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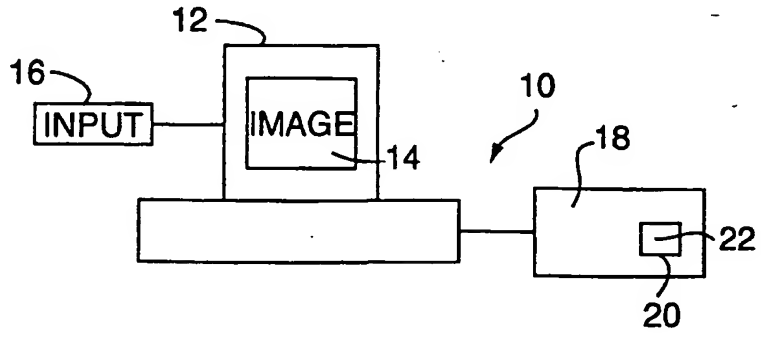


(57) Abstract: An apparatus for digitally generating an image comprises a photoconductor assembly, a corona assembly, and a light source assembly to generate a latent image on the photoconductor. The apparatus also includes a developer assembly that includes a developer, such as powder paint, to generate an image. The apparatus may include a fuser for generating a film image. The apparatus of the present invention may include a cartridge for storing and digitally applying adhesive to the image. Furthermore, the apparatus of the present invention includes a controller for selectively controlling voltages to control thickness of the image. Additionally, apparatus may include a consumable sheet to remove excess adhesive from the substrate.

WO 03/066337 A2

METHOD AND APPARATUS FOR MAKING SIGNS

The present application claims priority from and incorporates by reference U.S. Provisional Application Serial No. 60/354,982 filed February 8, 2002.

BACKGROUND OF THE INVENTION

1.Technical Field

[0001] The present invention relates to an apparatus and method for signmaking and, more particularly, to an apparatus and method for additive signmaking and to an apparatus and method for making durable signs.

2. Background Art

[0002] The signmaking industry was revolutionized by technology invented and implemented by Gerber Scientific, Inc. of South Windsor, Connecticut, a common assignee with the present invention. Several inventions relating to signmaking are described in U.S. Patent Nos. 5, 537, 135 and 4, 467, 525, which disclose an apparatus for printing and cutting signs on sheet material. Such signmaking apparatus includes a computer for storing image data and a printer which, based on the image data, applies colorant onto a vinyl sheet material adhered to a backing sheet. Once the desired image is printed, the sheet material is then transferred to a cutter machine. The cutter cuts through the vinyl sheet material around the contour of the image, leaving the backing sheet intact. Subsequent to the cutting operation, the unwanted vinyl material is removed or weeded from the sheet material. The desired image is subsequently applied to a transfer sheet and then to the final product.

[0003] Although the above-described method and apparatus have enjoyed great success and popularity, there are several drawbacks. First, the weeding process results in a significant amount of non-recyclable waste. Additionally, the

weeding process is labor intensive and time consuming. Furthermore, the weeding process can reduce the quality of the finished sign, because when the excess vinyl material is weeded, the sign image can become damaged. Additional difficulties associated with transferring the printed sheet material from the printer to the cutter include proper alignment between the printer and the cutter. Moreover, the cutter must be properly calibrated with respect to the printer.

[0004] U.S. Patent No. 5,871,837 to Adair entitled "Method of Fixing an Image to a Rigid Substrate" discloses a method of fixing an image to a rigid substrate coated with a thermally tackifiable coating. More specifically, the patent discloses a process wherein the image is printed onto a transfer film, the image bearing surface of the transfer film is then joined in pressing contact with a thermoplastic coating which has been warmed to a softened or tacky state. Once the thermoplastic coating is cooled to a hard, durable state, the transfer film is removed, leaving the image securely affixed to the rigid substrate. However, the process disclosed in the Adair patent has limited use. The Adair method is not practical, for example, for generating a sign for a car door. More specifically, the whole car door would have to be coated with the tacky material with the image then being transferred onto the coated door. However, once the image is adhered, the image will be surrounded by additional polymer, resulting in background haze around the image. Therefore, although the Adair patent provides an alternative to conventional signmaking, the Adair method is limited and is frequently impractical.

[0005] Another shortcoming of conventional signmaking is that the signs are not sufficiently durable for many purposes.

[0006] Although automated signmaking has significantly improved the time consuming process of manual signmaking, it is still desirable to further simplify and

improve the signmaking process by eliminating the waste resulting from weeding and by generating a more durable image.

SUMMARY OF THE INVENTION

[0007] According to the present invention, an apparatus and method for an Additive Signmaking™ Process includes a printer for generating a desired image either on a final substrate or a carrier sheet with the image then being transferred from the carrier sheet onto the final substrate. The generated image is "built up" on the carrier sheet or substrate to form a sign, thereby eliminating the need for the weeding process.

[0008] According to one aspect of the present invention, referred to herein as an Adhesive Split Transfer™ Process, the printer initially prints the image onto a carrier sheet. A layer of adhesive is then applied onto the carrier sheet with the image printed thereon. Subsequently, a substrate is joined with the carrier sheet such that the layer of adhesive and image are disposed therebetween. Once the carrier sheet is removed, the image remains adhered to the substrate, completing the Adhesive Split Transfer™ Process. If necessary, the image may be cured onto the substrate for improved adherence. The Adhesive Split Transfer™ Process simplifies the signmaking process by consolidating the printing, cutting and weeding operations that are required by existing methods into a single operation. One advantage of the Additive Signmaking™ Process, in general, and of the Adhesive Split Transfer™ Process, specifically, is that the weeding process is no longer necessary, thus eliminating the waste resulting therefrom, reducing potential damage to the sign, and decreasing labor costs.

[0009] According to another aspect of the present invention, an apparatus and method for the Additive Signmaking Process includes a printer adapted to print a

durable film image on a substrate. The printer includes a developer subsystem adapted to receive developer such as powder paint or powder toner. The developer subsystem can accommodate either a single or dual component developer. According to another embodiment, the developer subsystem includes multiple developer cartridges that are adapted to receive multiple substances, including, but not limited to powder paint or toner paint, clear coat, and/or adhesive. Using a printer with digitally applied powder paint or toner to form a durable film image revolutionizes the signmaking process. Digital application of powder paint for signs allows fabrication of durable signs without a weeding process.

[0010] According to another aspect of the present invention, an apparatus and method for the Additive Signmaking Process includes a printer that allows control of various voltages therein for varying the amount of colorant deposited resulting in changing the thickness of the printed image and in allowing use of different products.

[0011] According to a further aspect of the present invention, an apparatus and method for the Additive Signmaking Process includes a printer that allows the digital application of adhesive onto an image, substantially placing an adhesive in register with the image, for subsequent application of the image with adhesive placed thereon. Digital application of adhesive onto an image significantly simplifies the signmaking process. Digital application of an adhesive eliminates the need to use coated sheet material that requires subsequent weeding.

[0012] According to a further aspect of the present invention, an apparatus and method for the Additive Signmaking Process includes a printer adapted to receive a substrate for application of images thereon such that the substrate has a predetermined thickness and does not require further transfer of the image therefrom. Alternatively, an image can be generated and placed onto a carrier sheet,

such as polyvinylflouride sheet, for subsequent transfer to a substrate. According to another aspect of the present invention, the image is electrostatically transferred onto a sign substrate.

[0013] According to a further aspect of the present invention, a layer of adhesive is applied over a substrate. An image is built atop of the adhesive. A consumable sheet is then brought in contact with the substrate to remove excess adhesive, which is still disposed on the substrate, such that once the consumable sheet is separated from the substrate, the image remains on the substrate with the adhesive disposed therebetween.

[0014] The present invention introduces the concept of Additive Signmaking™ Process, wherein an image is built on top of a substrate without the need for weeding unnecessary material. The image can be either permanently adhered to the substrate or be temporarily placed on a carrier sheet and subsequently transferred onto a final substrate. The image can be built up with use of a variety of apparatus' and/or methods including, but not limited to, use of different colorants, multiple layers of colorants, clear coating, protective coating and/or adhesive. The present invention also introduces a concept of digitally applying adhesive onto a substrate. Furthermore, the present invention introduces another concept of applying adhesive over the entire substrate, building up an image atop of adhesive, and then removing excess adhesive. Thus, the concepts introduced by the present invention result in improved quality of the final product, as well as savings in time, labor, and materials.

[0015] The foregoing and other advantages of the present invention become more apparent in light of the following detailed description of the exemplary embodiments thereof, as illustrated in the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

[0016] **FIG. 1** is a schematic representation of a signmaking system including a computer and a printer;

[0017] **FIG. 2** is an enlarged, simplified, perspective view of the printer of **FIG. 1**;

[0018] **FIG. 3** is a block diagram of a process for printing a sign onto a carrier sheet for subsequent transfer to the final location using the signmaking system of **FIG. 1**;

[0019] **FIG. 4** is a front view of a carrier sheet with an image printed thereon in accordance with the process of **FIG. 3**;

[0020] **FIG. 5** is a side view of the carrier sheet and the image of **FIG. 4**;

[0021] **FIG. 6** is a partially broken away, front view of the carrier sheet with the image printed thereon and adhesive, in accordance with the process of **FIG. 3**;

[0022] **FIG 7** is a side view of the carrier sheet, the image and the adhesive of **FIG. 6**;

[0023] **FIG. 8** is a partially broken away, front view of the carrier sheet, the image, the adhesive and substrate, in accordance with the process of **FIG. 3**;

[0024] **FIG. 9** is a side view of the carrier sheet, the image, the adhesive and the substrate of **FIG. 8**;

[0025] **FIG. 10** is a partially broken away, front view of the carrier sheet with excess adhesive, in accordance with the process of **FIG. 3**;

[0026] **FIG. 11** is a front view of the substrate with the image adhered thereto, in accordance with the process of **FIG. 3**;

[0027] **FIG. 12** is a schematic representation of a printer for an Additive Signmaking™ Process, according to another embodiment of the present invention;

[0028] FIG. 13 is a schematic representation of components of the printer of FIG. 12;

[0029] FIG. 14 is a schematic representation of one embodiment of a developer subsystem of FIG. 13;

[0030] FIG. 15 is a schematic representation of another embodiment of a developer subsystem of FIG. 13;

[0031] FIG. 16 is a schematic representation of another embodiment of components of the printer of FIG. 12;

[0032] FIG. 17 is a schematic representation of a further embodiment of components of the printer of FIG. 12;

[0033] FIG. 18 is a schematic representation of a further embodiment of components of the printer of FIG. 12;

[0034] FIG. 19 is a block diagram of a process for printing a sign onto a substrate using the signmaking system of FIG. 1;

[0035] FIG. 20 is a schematic representative of an apparatus for generating a sign;

[0036] FIG. 21 is a schematic representation of a side view of a carrier sheet with an adhesive layer to be engaged by an ink foil;

[0037] FIG. 22 is a schematic representation of the side view of the carrier sheet after engagement with the ink foil of FIG. 20;

[0038] FIG 23 is a schematic representation of an apparatus for generating signs; and

[0039] FIG. 24 is a schematic representation of an another embodiment of an apparatus for generating signs.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

[0040] Referring to **FIG. 1**, an Additive Signmaking™ System **10** for an Additive Signmaking™ Process, according to one aspect of the present invention, includes a programmable computer **12** for generating an image **14** based on an input data **16**. The system **10** also includes a printer **18** which communicates with the computer **12**. The printer **18** includes at least one developer cartridge **20** that is filled with developer **22**.

[0041] Referring to **FIG. 2**, in an Adhesive Split Transfer™ Process, according to one aspect of the present invention, a carrier sheet **24** having a first carrier side **26** and a second carrier side **28** is placed into the printer **18**. The printer **18** generates an image **30** having a first image side **32** and a second image side **34**, as indicated by A2 in **FIG. 3** and best seen in **FIGS. 4** and **5**. The image **30** is transferred onto the first side **26** of the carrier sheet **24** within the printer **18**, as seen in **FIGS. 2, 4** and **5**. In the preferred embodiment of the present invention, the image **30** is reverse printed or a mirror image is printed onto the carrier sheet **24**.

[0042] Referring to **FIGS. 3, 5** and **7**, once the image is printed onto the carrier sheet **24**, an adhesive layer **36** is applied onto the first side **26** of the carrier sheet **24** and the first side **32** of the image **30**, as indicated by A4 in **FIG. 3**. A substrate **38** is subsequently joined with the carrier sheet **24** such that the adhesive layer **36** and the image **30** are sandwiched therebetween, as indicated by A6 in **FIG. 3** and shown in **FIGS. 8** and **9**. The substrate **38** and the carrier sheet **24** with the image **30** and adhesive **36** disposed therebetween can be pressed together for the film image **30** to properly adhere to the substrate **38**. Then, the carrier sheet **24** is removed from the substrate **38**, as indicated by A8 in **FIG. 3** and shown in **FIG. 9**. The adhesive **36** that was in direct contact with the carrier sheet **24** adheres to the carrier sheet and is

removed from the substrate **38**, as shown in **FIG. 10**. With the removal of the carrier sheet **24** and excess adhesive **36** from the substrate **38**, the film image **30** remains properly adhered to the substrate **38**, completing the Adhesive Split Transfer process, as shown in **FIG. 11**. Optionally, the substrate **38** and image **30** may be additionally cured for improved adherence of the film image onto the substrate. Various curing processes can be used, including but not limited to, ultraviolet light treatment, infrared heating, RF heating and/or conventional heating.

[0043] The adhesive **36** can be any type of adhesive, as long as the adhesive has preference for the carrier sheet **24** over the substrate **38**. Several different techniques can be used to apply the adhesive. One approach is to use liquid adhesives applied with a wire wrapped drawdown bar. One type of the wire wrapped drawdown bar is manufactured by Paul N. Gardner, Inc. of Pompano Beach, Florida. To obtain the appropriate coverage with the adhesive, the adhesives can be thinned to reduce the surface tension of the adhesive. Examples of such liquid adhesives are Covinax 386™ manufactured by Franklin International, Inc. of Columbus, Ohio and ScotchGrip 4224™ manufactured by 3M Corporation of St. Paul, Minnesota. In the preferred embodiment, the liquid adhesives were thinned with deionized water and dish soap according to the following composition: 50 ml of adhesive, 50 ml of water, and 5 ml of Joy™ dish soap. Joy™ dish soap is fabricated by Proctor & Gamble of Cincinnati, Ohio. However, numerous other liquid adhesives can be used, as long as the adhesive has preference for the carrier sheet.

[0044] Other types of adhesive that can be used are pressure sensitive adhesive films. These films are from a class known as adhesive transfer films, that include adhesive only, rather than adhesive and some other supporting film. The most commonly used adhesive films are manufactured by Xyron, Inc. of Scottsdale,

Arizona and are applied with the Xyron 850™ laminator, also manufactured by Xyron, Inc.

[0045] In the Adhesive Split Transfer Process, there are four (4) important bonds:

1. The bond between the image and the carrier sheet ("Image/Carrier");

2. The bond between the image and the adhesive ("Image/Adhesive");

3. The bond between the adhesive and the carrier sheet ("Adhesive/Carrier"); and

[0046] The bond between the adhesive and the substrate ("Adhesive/Substrate").

[0047] The Adhesive Split Transfer Process will occur when the following set of relationships between the bond strengths exists:

1. The Image/Adhesive bond is stronger than the Image/Carrier bond;

2. The Adhesive/Substrate bond is stronger than the Image/Carrier bond; and

3. The Adhesive/Carrier bond is stronger than the Adhesive/Substrate bond.

[0048] Any combination of adhesive, carrier, and substrate that satisfies all three (3) of these relationships may be used for the Adhesive Split Transfer Process. The toner used to generate the image must also satisfy the above-identified relationships.

[0049] Therefore, the substrate can be fabricated from any material that allows the substrate, in the non-image area, to release adhesive to the carrier sheet and, in the image area, allows adhesive to bond the film to the substrate. The carrier sheet

can be fabricated from any material that will not permanently bond to the image and is preferred over various substrates by the adhesive in the non-image area. In the preferred embodiment, Gerber 220™ vinyl and Gerber 225™ vinyl were used as the carrier sheet. Gerber 220™ vinyl and Gerber 225™ vinyl are products of Gerber Scientific, Inc. of South Windsor, Connecticut.

[0050] The developer can be any type of toner used in standard printers. However, in one embodiment of the present invention, the developer is either a powder paint or a dual component developer comprising ferrite carrier beads and powder paint or powder toner, as discussed in greater detail below. In the preferred embodiment, the dual component developer comprises 80-99% (eighty to ninety nine percent) ferrite carrier beads and 1-20% (one to twenty percent) powder paint or powder toner. However, in the most preferred embodiment, the developer comprises 90-95% ferrite carrier beads and 5-10% powder paint or powder toner. Use of the toner that includes powder paint or powder toner results in the generation of a durable film image. Powder Paint comprises resin and pigment is selected to be outdoor durable and UV stable.

[0051] The Additive Signmaking™ Process, in general, and the Adhesive Split Transfer™ Process, in particular, of the present invention simplifies the signmaking process by consolidating the printing, cutting and weeding operations required by conventional methods into a single operation. One advantage of the present invention is that the weeding process is no longer necessary, thus eliminating the waste resulting therefrom, potential damage to the sign during the weeding process, and labor costs therefor. Another advantage is that when powder paint or powder toner is used, the image generated is durable, with the powder paint generated image, the image could withstand outside elements for prolonged period of time. A further advantage of the Additive Signmaking Process and of the Adhesive Split

Transfer Process is that there are no limitations on where the signs can be applied. For example, these processes overcome the drawbacks of the U.S. Patent No. 5,871,837, as discussed in the Background of the Invention section of the present invention.

[0052] Referring to **FIG. 12**, according to another aspect of the present invention, an Additive Signmaking™ System **110** for generating a durable film image **114** includes a printer **118**. The durable film image **114** is essentially "built up" onto a substrate **120**, according to the present invention. The substrate **120** has a first substrate side **122** and a second substrate side **124**. The printer **118** includes a housing **126** with an input opening **128** for intaking the substrate **120** and an output opening **130** (not shown in **FIG. 12**) formed therein for allowing egress of the substrate **120**.

[0053] Referring to **FIG. 13**, in one preferred embodiment, the printer **118** is an electrophotographic printer and includes a substrate path **134** extending from the printer intake opening **128** to the printer output opening **130**. The printer also includes a photoconductor **136**, rotating in a photoconductor rotational direction, indicated by an arrow **138**, a charge corona assembly **140**, a light scanner assembly **142**, a developer subsystem **144**, a transfer corona assembly **146**, and a cleaner assembly **148** all disposed in proximity to the photoconductor **136**. In the preferred embodiment, the printer **118** also includes a fuser assembly **150** disposed downstream from the photoconductor **136** along the substrate path **134**. The printer **118** further includes a controller **152**.

[0054] The photoconductor **136** includes a ground layer **154** and a photoconductive surface layer **156** disposed radially outward of the ground layer **154** to define a photoconductive surface **158**, as is known in the art. The charge corona assembly **140** includes a corona wire **160** enclosed within a corona cage **162**,

that is at ground potential, and a corona screen **164** interposed between the corona wire **160** and the photoconductive surface **158**. The corona wire **160** is held at high voltage for generating ions that bombard the photoconductive surface layer **156** with the screen **164** controlling the level of charge that builds on the photoconductive surface layer **156**.

[0055] The light scanner assembly **142** includes a light source **166** which selectively discharges portions of the photoconductive surface layer **156** to generate a latent image **170** thereon. The light source **166** can be any light source which can include, but not be limited to a laser source, as is used in the preferred embodiment, or an LED source. The selective discharge of the light source **166** is digitally controlled by the controller **152** to generate the latent image **170**.

[0056] The developer subsystem **144** includes a cartridge **172** that forms a cartridge opening **174** to allow communication with the photoconductor **136**. The cartridge **172** houses the developer or toner **176** as well as a developer roller **178**, disposed substantially adjacent to the cartridge opening **174**, and a plurality of mixers **180**. The developer roller **178** is rotated in the developer roller direction, as indicated by an arrow **182**, which is typically opposite to the photoconductor rotation direction **138**. The mixers or augers **180** are activated to continually mix the developer within the cartridge **172**. The developer comprises a plurality of developer particles **184**.

[0057] The transfer corona assembly **146** is disposed on the opposite side of the substrate **120** from the photoconductor and includes a transfer corona wire **186** housed in a transfer corona housing **188** that has an opening **190** facing the substrate **120**.

[0058] The fuser subassembly **150** is disposed downstream from the transfer corona assembly **146** along the substrate path **134** and comprises a fuser **192** for

fusing and/or curing the image onto the substrate **120**. The fuser may be a number of various systems, including, but not being limited to, ultraviolet light, infrared heat, conventional heat, combination of heat and pressure and/or other types of fusing means. However, in the preferred embodiment, it is desirable not to use some of the silicone oils that are typically used in conventional systems to prevent "Hot Offset". The oil used in conventional systems is invariably transferred to the surface of the printed image. This oil now interferes with the bond between the powder toner/powder paint and whatever type of adhesive is applied over it. If the bond between the adhesive and the powder toner/powder paint is not sufficiently strong, the process will be compromised.

[0059] Placing the unfused image and carrier sheet in a convection oven for about one minute (1 min.) at approximately 300°F (three hundred degrees Farenheight) has proven to be satisfactory for fusing powder toner without introducing any silicone oil to the surface of the image. One type of the oven that can be used is a VWR Model 1320 Convection Oven, manufactured by VWR Scientific Products, Inc., Bridgeport, New Jersey.

[0060] This fusing process is also a preferred embodiment for the Adhesive Split Transfer Process described above.

[0061] The cleaning subassembly **148** is disposed substantially adjacent to the photoconductor **136** to clean the photoconductive surface **158** for accepting a subsequent image.

[0062] In operation, the charge corona assembly **140** generates a substantially uniform charge on the photoconductive surface layer **156**. Subsequently, as the photoconductor **136** is rotated in the photoconductor rotational direction **138**, the light source **166** selectively discharges portions of the photoconductive surface layer **156** to digitally generate a latent image **170** of a final product. The resultant latent

image **170** comprises a "background" portion **194** which has an original corona charge and an "image" portion **196**, that has been digitally generated by the light source **142**, having an image charge, as shown in **FIG. 14**. However, the "image" portion can have the original corona charge and the "background" portion could be digitally discharged by the light source.

[0063] As the latent image **170** is generated, the photoconductor **136** is further rotated, toward the developer subsystem **144**, and the latent image **170** is developed by selectively attracting developer particles **184** of the developer **176** disposed in the developer subsystem.

[0064] Referring to **FIG. 14**, the developer **176**, having a predetermined developer charge is attracted to the latent image **170**. More specifically, the developer is charged such that the developer particles **184** are attracted to the image portion **196** of the latent image **170** and not to the background portion **194** of the latent image. Alternatively, a developer with a developer charge opposite in sign to the predetermined developer charge can be attracted to the background portion of the latent image. Although it is shown in **FIG. 14** that the background portion **194** of the latent image **170** has a positive charge and the image portion **196** has a negative charge, the opposite is within the scope of the present invention. The exact charge of each portion is not critical as long as one portion of the image attracts toner particles and the other portion does not.

[0065] Referring to **FIG. 15**, the developer subsystem **144** can be also a dual component developer system **244** that includes a developer roller **278** rotating in the developer roller direction **282** and a plurality of mixers or augers **280** and dual component developer **276**. The developer roller **278** includes at least one magnet **283**. The dual component developer **276** comprises a plurality of toner particles **284** and a plurality of carrier particles **285**. The carrier particles, in the preferred

embodiment of the present invention, are ferrite particles of approximately 10-100 microns (μm) diameter that have been coated with a polymer. One type of carrier particles used was Teflon™ coated ferrite powder (Type 13) fabricated by Vertex Image Products, Inc. of Yukon, Pennsylvania. However, other types of carrier particles can be also used. In the preferred embodiment of the present invention, the toner particles are either toner paint or powder paint. The size of the toner or powder paint particles is smaller than the size of the carrier particles. The toner particles must also have the ability to be triboelectrically charged by the surface coating of the carrier powder when the carrier powder and the toner particles are mixed together.

[0066] In operation, the carrier particles **285** and the toner particles **284** are mixed within the dual component developer system. The magnet generates a brush **287** of the toner/carrier mixture. The developer roller **278** is held at a voltage that generates a field between the developer roller and the latent image **170** which has been formed on the photoconductor **136**. The generated field strips the toner particles **284** away from the carrier particles **285** and deposits them on the photoconductor **136**, developing the latent image **170** into the film image.

[0067] According to one aspect of the present invention, the controller **152** allows variable control over the voltages of the first corona screen **164**, the developer roller **178**, and the transfer corona **146**, as seen in **FIG. 13**. In one example, the corona screen voltage was set to be between -100 volts and -1500 volts. The developer roller voltage was set to be approximately -1000 volts. The transfer corona voltage was set to be between -3,500 volts and -6,000 volts. Two types of voltage differences were set up in the dual component developer system to control the quality of the final image. The first voltage difference was defined between the image portion of the latent image and the developer roller **178**. As an example, the

charge corona screen voltage set the photoconductor charge to be between -100 volts and -1,500 volts. The laser then discharges the background portion of the latent image, leaving the image portion of the latent image at some voltage between -100 volts and -1,500 volts. The dual component developer imparts a positive charge on the powder paint particles. The developer roller voltage sets up an electrical field between the developer roller **178** and the image portion on the photoconductor. The strength of the field is determined by the difference between the charge corona screen voltage and the developer roller voltage. The more negative the charge corona screen voltage, and thus the image portion voltage, with respect to the developer roller voltage, the greater the force compelling the positively charged powder paint particles to transfer to the image portion. Voltages can vary and be opposite in sign for different system setup and/or powder paint.

[0068] The second voltage difference is defined between the background portion on the photoconductor, which has been discharged to near ground by the laser, and the developer roller. To avoid development of the background portion by the powder paint, it has been found that it was important to keep the potential of the developer roller below ground. In the preferred embodiment, the setting for the best image was with the corona screen being at approximately -1,200 volts and the developer roller at approximately -300 volts, thereby generating an approximately 1,500 volt difference between the developer roller and the image portion and an approximately 300 volt difference between the developer roller voltage and the background portion of the latent image.

[0069] The ability to vary the voltages at key points in the system also contributes to control of the amount of powder paint being deposited on the photoconductor and therefore, on the thickness of the resultant film image.

[0070] Referring to **FIG. 16**, according to another aspect of the present invention, an Additive Signmaking System **310** includes a printer **318** that is substantially analogous to the printer **118** described herein and depicted in **FIG. 14**. However, printer **318** includes a plurality of developers **344** disposed sequentially in close proximity to the photoconductor **336**. The printer **318** also includes an intermediate transfer belt **337** that is movable in a transfer belt direction **339** which is opposite to the photoconductor rotation direction **338**. The photoconductor **336**, the charge corona **340** and the light source **342** of the printer **318** are substantially similar to that of the printer **118**. However, the developers **344** include various substances that are digitally applied onto the photoconductor **336**, transferred to the intermediate transfer belt, and subsequently transferred onto a substrate. In one embodiment of the present invention, the first developer **345** includes powder paint or powder toner. The second developer **347** includes a different color of powder paint or powder toner. The third developer **349** includes a clear coat to deposit clear film onto the substrate. The fourth developer **351** includes an adhesive to be digitally applied through the photoconductor and the intermediate transfer belt onto the substrate.

[0071] In operation, the latent image first would be developed by attracting the toner or powder paint, as discussed above. The latent image with the powder paint would then be transferred onto the intermediate transfer belt, as a first image portion. Subsequently, another latent image could be developed with colored powder paint as a second image portion and transferred onto the intermediate transfer belt to be substantially in register with the first image portion. Subsequently, the clear coat from the third developer system would be applied to a third latent image as a third image portion which would be then transferred again onto the intermediate transfer belt to be subsequently in register with the first and

second image portions. Furthermore, with the first, second and third developer systems being inactivated, the fourth developer would digitally apply adhesive onto the photoconductor's latent image as a fourth image portion which then would be transferred onto the intermediate transfer belt to subsequentially overlap with the first, second and third image portions of the film image. The multiple image portions from the intermediate transfer belt would then be transferred onto the substrate.

[0072] This process would result in "building up" of the final film image comprising multiple layers. The types of layers and order of application of the layers could vary depending on particular requirements of the final film image product. The thickness of each layer can also vary from product to product as the voltages within the printer can be varied, as discussed above.

[0073] According to a further aspect of the present invention, the adhesive is digitally applied to either the first surface of the carrier sheet or the first image side of the film image. Adhesive is applied to areas where the film image has been or will be created. Digital application of the adhesive may be achieved through several techniques including electrophotography of a heat and/or pressure activated powdered adhesive, ink jetting of a liquid adhesive, or thermal transfer of a dry film adhesive. The digitally applied adhesives may be heat sensitive, pressure sensitive, or UV sensitive. One such type is Hot Melt powder adhesive manufactured by Union, Inc., Ridgefield, New Jersey. A protective film can be applied to cover the adhesive which is removed just prior to the application of the durable film image to the final substrate, or the printer may apply the adhesive to the carrier sheet prior to creation of the film image. The adhesive and the film image may then be lifted from the carrier sheet with transfer tape and applied to the final substrate, as is typical in traditional signmaking.

[0074] According to an additional aspect of the present invention, the adhesive contains colorant and has a dual purpose of an adhesive and a colorant. The colorant can be either pigment or dye.

[0075] Referring to **FIG. 17**, although a multiple developer system **318**, described above, included a single photoconductor **336** and a plurality of developers **345, 347, 349** and **351**, system **418** may include a plurality of developers **445, 447, 449** and **457** corresponding to a plurality of photoconductors **437, 439, 441** and **443**. Each photoconductor would have a corresponding charge corona **440** and a transfer corona **446**. The image would be "built up" in a manner described above and include a plurality of digitally applied layers of developers, coatings and/or adhesive housed within the developers **445, 447, 449** and **457**.

[0076] Referring to **FIG. 18**, although the photoconductors **136, 336** have been described as a drum rotating in a photoconductor rotational direction **138, 338**, respectively, the photoconductors **136, 336** can be a photoconductor belt **536** with the printer **518** having substantially the same structure and functionality.

[0077] Additionally, although some systems include means for digital application of adhesive, in accordance with the teachings of the present invention, as discussed above, some systems may require means for applying adhesive **565**, shown in **FIG. 18**, wherein the means **565** is adapted to apply adhesive either digitally or globally over the entire substrate.

[0078] Referring to **FIGS. 16** and **17**, a voltage subassembly **353** and **453** is included in the printers **318, 418**, respectively. The voltage subassembly **353, 453** controls voltage within the printer and thereby allows use of various types of materials in the same printer. For example, protective coating, adhesive and various types of colorants can be used within the same apparatus. Additionally, the voltage assembly allows the generated image to have varying thickness, as discussed above.

[0079] Because of the wide variety of materials that may be used during printing with the Additive Signmaking Process, including, but not limited to: powder toner, powder paint, clear coat, and powdered adhesive, it is important to have the ability to use a single imaging system to image both positive or negative charging powders.

[0080] As discussed above, the charge corona system imparts a uniform negative charge on the surface of the photoconductor. Subsequently, areas of the photoconductor that are exposed to light from the light source are discharged to approximately ground. This process generates areas with two distinct levels of charge. Positive charging powders will be attracted to the areas of the photoconductor that remain at the original level of charge and negatively charged powders are attracted to the discharged areas of the photoconductor. When a positive charging powder is to be imaged, the light source is used to discharge the "negative" of the image data. The powder is then attracted to areas of the photoconductor that have not been discharged by the light source. A potential more negative than the original charge level of the photoconductor is then used to transfer the powder from the photoconductor to an intermediate roller or the carrier sheet. When a negative charging powder is to be imaged, the light source is used to discharge the "positive" of the image data. The powder is attracted to the areas of the photoconductor that have been discharged by the light source. A potential more positive than the discharged level of the photoconductor is then used to transfer the powder from the photoconductor to an intermediate roller or the carrier sheet.

[0081] The voltage subassembly **353, 453** accomplishes both of these tasks. In the best mode, Trek 610D High Voltage Supplies fabricated by Trek Inc. of Medina, NY were used to control the transfer potentials in the printer. For negative charging powders, the intermediate transfer roller voltage was set to +350V and the final

transfer roller voltage was set to + 1,200V. For positive charging powders, the intermediate transfer roller voltage was set to –950V and the final transfer roller voltage was set to –2,000V.

[0082] Referring to **FIGS. 19** and **20**, according to another aspect of the present invention, in a system **618**, substantially analogous to system **118** shown in **FIG. 13**, a sign such as, for example, a road sign or a car door is generated. There are several methods for generating a final sign. In accordance with one method of the present invention, the input data pertaining to an image is communicated to the computer and printed onto a sheet **620**. In one embodiment, the sheet **620** is a transfer or carrier sheet, as indicated by **B1** and **B2** of **FIG. 19**. In the preferred embodiment of the present invention, the transfer or carrier sheet is fabricated from polyvinylfluoride (PVF) material. It is preferable to reverse print the image for subsequent transfer. The unfused image is then electrostatically transferred to a sign substrate, as indicated by **B3**. Support **615**, such as a roller, disposed on the backside of the polyvinylfloride sheet **620** is held at approximately ground and the sign substrate, to which the image will be transferred, is held at approximately negative two thousand volts (-2,000V). Subsequently, the image is cured at approximately three hundred degrees Fahrenheit (300° F) for approximately ten minutes (10 min.), as indicated by **B4** in **FIG. 19**, to form a film image. Voltages can vary in sign and value depending on the properties of the powder paint or toner.

[0083] According to another method of generating a sign, the sheet **620** is a sign substrate with the image being generated directly onto the sign substrate, as indicated by **B1** and **B5** of **FIG. 19**, with the system **618** being adapted to receive the sign substrate for processing. The image is subsequently cured onto the sign substrate either within the apparatus by means **650** or subsequently outside of the system **618**.

[0084] The sign substrate is preferably a substantially flat plate such as a roadway sign or a car body or door. The sign substrate may be fabricated of any material that does not attenuate the electric field between the surface of the sign substrate and the surface of the PVF sheet to the point where it is insufficient to force the transfer of the powder from the surface of the PVF sheet to the surface of the sign substrate. Metals and conductive plastics work well, thin non-conductive materials may also be used. In the preferred embodiment of the present invention, an electrophotographic process was used to generate the image. However, other methods and systems can be used to generate the desired image. One type of a developer that can be used is developer mixture of polyester powder coating from Morton Powder Coatings, Inc. owned by Rohm & Haas Company of Philadelphia, Pennsylvania and flouropolymer coated ferrite from Vertex Image Products, Inc. of Yukon, Pennsylvania. In one embodiment, the dual component developer comprises 80-99% (eighty to ninety nine percent) ferrite carrier beads and 1-20% (one to twenty percent) powder paint or powder toner. However, in the most preferred embodiment, the developer comprises 90-95% ferrite carrier beads and 5-10% powder paint or powder toner. However, other developer mixtures can be used, either single or dual component.

[0085] Referring to **FIGS. 21 – 24**, in accordance with another embodiment of the present invention, the Additive Signmaking™ Process can be implemented by building up an image **729, 829, 929** on a carrier sheet **724, 824, 924** with an adhesive layer **730, 830, 930** disposed therebetween such that the adhesive layer has been pre-applied to the carrier sheet and excess adhesive **731, 831, 931** is subsequently removed from the carrier sheet. Thus, an adhesive layer **730, 830, 930** is initially applied onto a carrier or release sheet **724, 824, 924.** A colorant 728, **828, 928** is subsequently applied onto the adhesive layer **730, 830, 930** to built an image **729, 829,**

929 on top of the adhesive layer. The image adheres to the carrier sheet by means of the adhesive layer, now sandwiched therebetween. The portions of the carrier sheet without the image still have exposed adhesive portion or excess adhesive 731, 831, 931. A consumable sheet is then brought into contact with the carrier sheet and into direct contact with the excess adhesive 731, 831, 931 and with the image. The excess adhesive adheres to the consumable sheet 839, 939. When the consumable sheet is removed, the adhesive splits along the borders or the perimeter of the image, removing the unwanted portions of excess adhesive and leaving the previously printed image backed by the remaining adhesive on the carrier sheet.

[0086] Referring to FIGS. 21 and 22, in one embodiment, a thermal printer 718 is used to generate an image. In the preferred embodiment, a MAXX™ system has been used. The MAXX™ system is a signmaking apparatus manufactured by Gerber Scientific Products, Inc. of South Windsor, Connecticut, an assignee of the present invention. The MAXX™ system is described in U.S. Patent Nos. 6, 243,120 and 6,322,265, with their disclosures being incorporated herein by reference. However, other thermal printers can be used. As is well known in the art, a thermal printer or signmaking apparatus includes a thermal printhead that comes into contact with an ink foil to generate an image on a substrate.

[0087] Referring to FIG. 21, in a thermal system 718, an ink foil 720 comes into contact with an adhesive layer 730 disposed on a carrier sheet 724. The ink foil 720 comprises a foil 726 with resin 728 disposed thereon. As is known in the art, resin or colorant 728 is subsequently separated from the foil to generate an image 729. In the preferred embodiment of the present invention, the release or carrier sheet 724 is coated with the adhesive layer 730 and is placed into the thermal printer with the adhesive layer 730 facing the ink foil 720. In this embodiment, the ink foil 720 also serves as a consumable sheet.

[0088] In operation, referring to FIG. 22, as the thermal system 718 selectively energizes printing elements 732 of a thermal printhead 734 that come into contact with the carrier sheet 724 with the foil 720 and the adhesive layer 730 disposed therebetween to generate an image, the resin 728 that is disposed substantially below the energized printing elements 732 is transferred from the foil 720 onto the carrier sheet 724, atop of the adhesive layer 730, thereby printing the image 729 onto the adhesive layer 730 of the carrier sheet 724. Excess adhesive 731 or portions of the adhesive layer 730 that do not have resin 728 disposed atop thereof, adhere to the resin remaining on the foil 720 and are, thereby, removed from the carrier sheet 724 and rolled onto the takeup roll (not shown) with the used foil. Thus, when the printing of the image 729 is completed, the carrier sheet 724 is free of exposed or excess adhesive 731 except in the area of the image, and includes the image disposed thereon with the adhesive layer sandwiched between the carrier sheet and the image. Subsequently, the image can be transferred with transfer tape onto its final location. Optionally, the carrier sheet with the adhesive layer and the image can be cured.

[0089] The adhesive layer 730 can be either preapplied onto the carrier sheet or applied internally within the system 718 by an adhesive application means 719.

[0090] The release or carrier sheet 724, adhesive 730, and foil 720 can be a variety of products. However, the carrier sheet must allow the release of adhesive with the adhesive having a preference for the foil over the carrier substrate and with resin having a preference for the adhesive over the foil when the foil is in contact with the energized printing element. In the preferred embodiment, polymer coated paper, such as the backside of the carrier used with Gerber Quantum 4000™ vinyl, a product of Gerber Scientific, Inc. of South Windsor, Connecticut, was used. One

type of adhesive is Covinax 386™, manufactured by Franklin International, Inc. of Columbus, Ohio. Any type of ink foil can be used.

[0091] Referring to **FIG. 23**, in another embodiment for this printing technique, an ink jet system **818** is used to apply ink or colorant **828** to form an image **829** over the pressure sensitive adhesive film **830**. The ink jet system **818** is either adapted to receive a carrier sheet **824** with adhesive **830** applied or to apply adhesive **830** to the carrier sheet **824** by adhesive application means **819**. The ink jet system **818** also includes at least one ink jet print head **834** to dispense ink **828** to form the image **829** atop the carrier sheet with the adhesive layer **830** disposed therebetween. The ink jet system **818** further includes a curing station **835** for curing ink onto the carrier sheet **824**. The curing station **835** can provide any type of curing, including UV cure lamp, infrared, laser, thermal and/or others. The ink jet system **818** also includes means for removing excess adhesive **837**. The means for removing excess adhesive **837** includes a consumable sheet **839** that contacts the carrier sheet with the image and excess adhesive thereon such that upon separation of the consumable sheet and the carrier sheet, the excess adhesive **831** remains on the consumable sheet **839** and the carrier sheet **824** or substrate has the image disposed thereon with the adhesive **830** disposed therebetween.

[0092] In one embodiment, the means for removing excess adhesive **837** is a consumable sheet, such as foil, rolled on a supply roll **841** with the foil being dispensed from the supply roll and taken up by a take up roll **843**. A pressure roller **845** is disposed between the supply roll and the take up roll. The pressure roller acts on the back side of the foil to apply a substantially uniform pressure which promotes the desired adhesive bonding between the foil **839** and the exposed, unwanted adhesive **831**. The take up roller acts to peel and store the foil and the excess adhesive. After the foil and unwanted adhesive have been removed, the release or

carrier sheet **824** is free of the excess adhesive except where the adhesive exists underneath the printed image.

[0093] The non-contact nature of ink jet printing is desirable because it simplifies the problems associated with handling the adhesive coated carrier sheet. UV cure inks are desirable because they are 100% solids (during the UV cure process, 100% of the liquid ink is converted to solid polymer) and will form a film over the adhesive when printed. Traditional water-based or solvent-based inks will not form a solid film upon drying and, therefore, may not provide sufficient structure for blocking of the adhesive. Phase change inks where the colorant is disbursed in wax are also 100% solid and will form a film over the adhesive. For sign making applications, the UV cure inks are generally preferred over phase change inks because they provide a more durable image.

[0094] Referring to **FIG. 24**, in a further embodiment of the present invention, an electrophotographic system **918** includes means for electophotographically generating an image **933**, means for fusing **935**, and means for removing excess adhesive **937**. The system **918** may or may not include means for applying adhesive **919**, as discussed above. The means for electophotographically generating an image **933** can have various configurations, some of which are described above and shown in **FIGS. 13-18**. Thus, the means for electrophotographically generating an image **933** builds a single or multiple color powder image on a photoconductor roller or belt or a final transfer roller or belt **956**. The image is then electrostatically transferred onto the adhesive layer **930** disposed atop of the carrier or release sheet **924**. The imaged powder toner or powder paint **928** is subsequently fused into a film image **929** disposed atop of the carrier sheet with the means for fusing **935**. The carrier sheet **924** with the fused image **929** and excess adhesive **931** still disposed thereon is brought into contact with the consumable sheet **939** of the means for removing

excess adhesive **937**. In the embodiment shown, the means for removing excess adhesive is substantially analogous to the means shown in **FIG. 23** and described above.

[0095] The powder paint or powder toner materials **928** used for imaging in the electrophotographic systems described above form a solid film that can be either used as a sign on the carrier sheet or subsequently transferred onto a final substrate.

[0096] For the embodiments describing removal of excess adhesive, it is not necessary to remove the consumable sheet **839, 939** in the printer. Rather, it may be desirable to leave the consumable sheet atop the carrier sheet and the excess adhesive as a protective layer to be removed at the time of application to the final substrate.

[0097] For multi-color printing wherein multiple foils or colorants are used sequentially, in the preferred embodiment, it is preferable to initially print over the entire image area with clear-abrasion guard, white ink or similar transparent ink to remove an appropriate amount of adhesive from the carrier sheet while leaving adhesive on the entire image area. Then, various colors or half-tone colors can be printed, as necessary. For example, in some instances there will be a physical limit on the smallest amount of adhesive that can be reliably removed by the above-described technique. In those situations, as a first imaging step, a backing material can be applied initially upon which subsequent colors will be printed. Process color half-tone printing techniques, which are employed to generate picture images provide the clearest example of this situation. The small dots of Cyan, Magenta, Yellow, and Black color that are used to generate half-tone images are generally too small to have the adhesive split around them. To circumvent this problem, a backing layer of, usually but not necessarily, white, transparent or clear, is applied over the entire image area. By printing a clear coating over the entire image area, the

adhesive is only required to split along the perimeter of the image area rather than along the perimeter of each individual dot used to generate the half-tone image. This technique can also be used to simplify more basic multi-color printing when multiple colors are serially applied to generate a multi-color image, such as in thermal transfer printing, ink jet printing or electrophotographic printing. If a backing layer is first printed over all areas that are to receive any color, the unwanted adhesive may be removed at the beginning of the sign making process. All subsequent printing steps occur in the absence of any exposed adhesive, which simplifies material handling in the printer.

[0098] The Adhesive Split Transfer process described above can be also used with printers **18, 118** and **318** to print a durable film image that can be subsequently subjected to the Adhesive Split Transfer process, as mentioned above.

[0099] The present invention introduces the concept of the Additive Signmaking Process, as opposed to other known processes of signmaking, such as weeding. The Additive Signmaking Process includes building an image or film onto a substrate. The built up film or image either can be permanently adhered to the substrate or subsequently transferred onto a final substrate. The building up of the image or film can involve either a single layer of developer or multiple layers, including, but not limited to, different colors of developers, clear coating film and/or adhesive. The Additive Signmaking Process has great advantages over the weeding signmaking process. The Additive Signmaking Process eliminates the need for weeding excess material from the sign, thus eliminating waste from the weeding and minimizing potential damage to the actual sign. Use of powder paint and powder toner in signmaking has tremendous advantages. Use of powder paint and powder toner in signmaking yields durable signs capable of being used outdoors.

[0101] Although powder paint is well known in some industries, such as automotive, use of powder paint in the signmaking industry has not been known. Similarly, although powder toner has been used in office laser printers and copiers for regular printing operations, powder toner in durable signmaking has not been used.

[0102] While the present invention has been illustrated and described with respect to a particular embodiment thereof, it should be appreciated by those of ordinary skill in the art, that various modifications to this invention may be made without departing from the spirit and scope of the present invention. For example, although the printer **118** was described as having a preferred configuration, many other configurations are within the scope of the present invention. Additionally, although the preferred embodiment describes an electrophotographic printer, other types of printers, such as thermal, inkjet, and/or laser, can be used to generate an image and/or durable film image to be used in the Additive Signmaking Process and/or Adhesive Split Transfer Process.

We Claim:

1. A method for generating an image product comprising the steps of:

generating an image on a carrier sheet;

applying an adhesive over said carrier sheet with said image;

joining said carrier sheet with said image and with said adhesive with a substrate; and

removing said carrier sheet with excess adhesive from said substrate, leaving said substrate with said image adhered thereto, thereby generating an image product.

2. The method according to Claim 1 further comprising an intermediate step of:

applying pressure to ensure attachment of said image with said adhesive onto said substrate prior to removing said carrier sheet with excess adhesive from said substrate and said image.

3. The method according to Claim 1 wherein said image is reverse printed onto said carrier sheet.

4. The method according to Claim 1 wherein said adhesive has preference for said carrier sheet rather than said substrate.

5. The method according to Claim 1 wherein said adhesive has preference for said carrier sheet rather than said substrate.

6. The method according to Claim 1 wherein a bond between said image and said adhesive is stronger than a bond between said image and said carrier sheet.

7. The method according to Claim 1 wherein a bond between said adhesive and said substrate is stronger than a bond between said image and said carrier sheet.

8. The method according to Claim 1 wherein a bond between said carrier sheet and said adhesive is stronger than a bond between said adhesive and said substrate.

9. The method according to Claim 1 wherein a bond between said image and said adhesive is stronger than a bond between said image and said carrier sheet, a bond between said adhesive and said substrate is stronger than a bond between said image and said carrier sheet, and a bond between said carrier sheet and said adhesive is stronger than a bond between said adhesive and said substrate.

10. The method according to Claim 1 wherein said film image is printed onto said carrier sheet using a laser printer.

11. The method according to Claim 1 wherein said film image is printed onto said carrier sheet using a thermal printer.

12. The method according to Claim 1 wherein said film image is printed onto said carrier sheet using an inkjet printer.

13. The method according to Claim 1 wherein said film image is printed onto said carrier sheet using a silk screening process.

14. The method according to Claim 1 wherein said image is a film image.

15. The method according to Claim 14 wherein said film image is a durable film.

16. The method according to Claim 15 wherein said durable film comprises powder paint.

17. The method according to Claim 15 wherein said durable film comprises pigmented resin.

18. The method according to Claim 15 wherein said durable film comprises UV curable ink.

19. The method according to Claim 1 further comprising a subsequent step of:

curing said substrate with said image to ensure attachment of said image with said adhesive to said substrate.

20. The method according to Claim 1 further comprising a step of:

fusing said image onto said substrate.

21. The method according to claim 20 wherein said step of fusing is performed by UV fusing.

22. The method according to claim 20 wherein said step of fusing is performed by heat fusing.

23. The method according to claim 20 wherein said step of fusing is performed by combination of UV and heat fusing.

24. The method according to claim 20 wherein said step of fusing is performed by infrared fusing.

25. A developer for use in an apparatus for generating an image comprising:

powder paint for being digitally applied onto a substrate forming an image.

26. The developer according to claim 25 wherein said image is a film image.

27. The developer according to claim 26 wherein said film image is a durable film image.

28. The developer according to claim 25 wherein said image is printed onto a final substrate.

29. The developer according to claim 25 wherein said image is printed onto an intermediate substrate for subsequent transfer.

30. The developer according to claim 25 wherein said powder paint is used in an electrostatic printer.

31. The developer according to claim 25 wherein said powder paint is used in an electrographic printer.

32. The developer according to claim 25 wherein said powder paint comprises a resin and pigment.

33. The developer according to claim 25 wherein said powder paint comprises resin and pigment and is outdoor durable and UV stable.

34. A developer for use in an apparatus for generating a film image comprising:

dual component developer with one of the components being powder paint.

35. The developer according to claim 34 wherein said image is printed onto a final substrate.

36. The developer according to claim 34 wherein said image is printed onto an intermediate substrate for subsequent transfer.

37. The developer according to claim 34 wherein said powder paint is used in an electrostatic printer.

38. The developer according to claim 34 wherein said powder paint is used in an electrographic printer.

39. The developer according to claim 34 wherein said powder paint is used in an electrophotographic printer.

40. An apparatus for digitally generating an image comprising:

a photoconductor moving in a photoconductor direction;

a first corona assembly disposed in proximity to said photoconductor to provide said photoconductor with a photoconductor charge;

a light source assembly disposed downstream of said first corona assembly for selectively discharging said photoconductor to digitally generate a latent image on said photoconductor;

a developer assembly disposed downstream of said light source assembly, said developer assembly including a plurality of cartridges for developing said latent image to result in formation of an image and for digitally applying at least one of selected from the group of adhesive and clear coat; and

a transfer mechanism for transferring said image from said photoconductor onto a substrate.

41. The apparatus according to claim 40 further comprising a fuser to fuse said image.

42. The apparatus according to claim 40 wherein said image becomes durable image after being fused.

43. An apparatus for digitally generating an image comprising:

a photoconductor moving in a photoconductor direction;

a first corona assembly disposed in proximity to said photoconductor to provide said photoconductor with a photoconductor charge;

a light source assembly disposed downstream of said first corona assembly for selectively discharging said photoconductor to digitally generate a latent image on said photoconductor;

a developer assembly disposed downstream of said light source assembly for developing said latent image to result in formation of an image; and

a cartridge for storing and applying adhesive.

44. The apparatus according to Claim 43 further comprising:

a transfer mechanism for transferring said image from said photoconductor onto a substrate.

45. The apparatus according to Claim 43 wherein said adhesive is applied selectively.

46. The apparatus according to Claim 43 wherein said adhesive is applied digitally.

47. The apparatus according to Claim 43 wherein said adhesive is applied globally onto a substrate.

48. The apparatus according to Claim 43 wherein said adhesive includes a colorant.

49. The apparatus according to Claim 43 further comprising an additional cartridge for storing and applying a protective coating over said image.

50. The apparatus according to Claim 43 wherein additional layers are digitally applied onto said image.

51. An apparatus for digitally generating an image comprising:

a photoconductor moving in a photoconductor direction;

a first corona assembly disposed in proximity to said photoconductor to provide said photoconductor with a photoconductor charge;

a light source assembly disposed downstream of said first corona assembly for selectively discharging said photoconductor to digitally generate a latent image on said photoconductor;

a developer assembly disposed downstream of said light source assembly for developing said latent image to result in formation of an image; and

a controller for selectively controlling voltages.

52. The apparatus according to Claim 51 wherein said controller varies voltage for varying thickness of said image.

53. The apparatus according to Claim 51 wherein said controller varies voltage to accommodate different materials.

54. The apparatus according to Claim 51 wherein a predetermined voltage difference is established between a developer roller disposed within said developer assembly and an image portion of said latent image.

55. The apparatus according to Claim 54 wherein said voltage difference is set to be approximately 1500 volts.

56. The apparatus according to Claim 51 wherein a predetermined voltage difference is established between a developer roller disposed within said developer assembly and a background portion of said latent image.

57. The apparatus according to Claim 56 wherein said voltage difference is set to be approximately 300 volts.

58. The apparatus according to Claim 51 further comprising:
a developer roller disposed within said developer assembly.

59. The apparatus according to Claim 58 wherein said latent image comprises a background portion and an image portion.

60. The apparatus according to Claim 59 wherein a first predetermined voltage difference is established between said developer roller and said image portion of said latent image and a second predetermined voltage difference is established between said developer roller and said background portion of said latent image.

61. The apparatus according to Claim 60 wherein said first predetermined voltage difference is set to be approximately 1500 volts and said second predetermined voltage difference is set to be approximately 300 volts.

62. The apparatus according to Claim 51 further comprising:

a fuser assembly to generate a film image.

63. The apparatus according to Claim 51 further comprising:

a transfer mechanism for transferring said image from said photoconductor onto a substrate.

64. An apparatus for digitally generating an image comprising:

a photoconductor moving in a photoconductor direction;

a first corona assembly disposed in proximity to said photoconductor to provide said photoconductor with a photoconductor charge;

a light source assembly disposed downstream of said first corona assembly for selectively discharging said photoconductor to digitally generate a latent image on said photoconductor;

a developer subsystem disposed downstream of said light source assembly, said developer subsystem including a developer for developing said latent image to result in formation of an image.

65. The apparatus according to Claim 64 further comprising a fuser assembly to cure said image to result in a film image.

66. The apparatus according to claim 65 wherein said fuser is a non contact fuser.

67. The apparatus according to claim 65 wherein said fuser does not deposit oil.

68. The apparatus according to Claim 64 further comprising:

a transfer mechanism for transferring said image from said photoconductor onto a substrate.

69 The apparatus according to Claim 68 wherein said transfer mechanism comprises a second corona disposed substantially adjacent to said substrate for generating a second corona potential field to effect the transfer of said image onto said substrate.

70. The apparatus according to Claim 68 wherein said transfer mechanism comprises:

an intermediate transfer belt for allowing said image be transferred from said photoconductor onto said intermediate transfer belt for subsequent transfer onto said substrate.

71. The apparatus according to Claim 64 further comprising a cleaner assembly disposed substantially adjacent to said photoconductor for cleaning said photoconductor for a subsequent operation.

72. The apparatus according to Claim 64 wherein said photoconductor is a drum rotating in said photoconductor direction.

73. The apparatus according to Claim 64 wherein said photoconductor is a belt moving in said photoconductor direction.

74. The apparatus according to Claim 64 wherein said first corona assembly comprises:

a first corona wire held at first corona wire voltage and generating ions that bombard said photoconductor;

a first corona screen disposed between said first corona wire and said photoconductor for controlling amount of charge that builds on said photoconductor; and

a first corona cage held at ground for housing said first corona wire.

75. The apparatus according to Claim 64 wherein said photoconductor includes a photoconductor surface adapted to be charged by said first corona assembly and adapted to be selectively discharged by said light source assembly to result in said latent image.

76. The apparatus according to Claim 64 wherein said light source assembly comprises a laser digitally controlled by a controller to selectively discharge said photoconductor.

77. The apparatus according to Claim 64 wherein said light source assembly includes an LED controlled by digital modulation to selectively discharge said photoconductor.

78. The apparatus according to Claim 64 wherein said developer subsystem comprises:

a cartridge for housing said developer;

a developer roller disposed within said cartridge in close proximity to said photoconductor for delivering such developer towards said photoconductor; and

a least one mixer disposed within said cartridge for mixing said developer within said cartridge.

79. The apparatus according to Claim 78 wherein said developer is powder toner.

80. The apparatus according to Claim 78 wherein said developer roller rotates in a direction opposite from said photoconductor direction.

81. The apparatus according to Claim 78 wherein said developer is a dual component developer and wherein said developer roller includes at least one magnet.

82. The apparatus according to Claim 81 wherein said dual component developer comprises:

a plurality of image particles; and

a plurality of carrier particles.

83. The apparatus according to Claim 82 wherein said image particles are powder toner.

84. The apparatus according to Claim 82 wherein said image particles are powder paint.

85. The apparatus according to Claim 82 wherein said carrier particles are ferrite particles coated with a polymer.

86. The apparatus according to Claim 64 wherein said developer is powder paint.

87. The apparatus according to Claim 64 wherein said image becomes a film image upon curing.

88. The apparatus according to claim 87 wherein said film image is durable.

89. The apparatus according to Claim 64 further comprising:

a controller for allowing variable control over the voltages.

90. The apparatus of Claim 89 wherein said controller allows variable control over the voltages to vary thickness of said image.

91. The apparatus according to Claim 89 wherein said controller defines a first voltage difference and a second voltage difference with said first voltage difference being defined between a developer roller disposed in said developer subsystem and image background and said second voltage difference being defined between background image and said photoconductor.

92. The apparatus according to Claim 64 wherein developer subsystem includes a plurality of developer cartridges.

93. The apparatus according to Claim 92 wherein at least one of said plurality of developer cartridges includes powder paint.

94. The apparatus according to Claim 92 wherein at least one of said plurality of developer cartridges includes powder toner.

95. The apparatus according to Claim 92 wherein at least one of said plurality of developer cartridges includes clear coat.

96. The apparatus according to Claim 92 wherein at least one of said plurality of developer cartridges includes adhesive.

97. A method for making a sign comprising the steps of:

generating an image for a sign; and

printing a powder image onto a transfer sheet to form an electrostatically charged powder image thereon.

98. The method according to Claim 97 further comprising a step of:

transferring said powder image from said transfer sheet onto a sign substrate such that said transfer sheet is maintained at approximately ground and said sign substrate is maintained at a predetermined voltage.

99. The method according to claim 98 wherein said transfer is an electrostatic transfer.

100. The method according to Claim 97 further comprising a step of:

curing said sign substrate at a predetermined temperature for a predetermined time.

101. The method according to claim 97 wherein said powder image is powder paint image.

102. The method according to claim 97 wherein said powder image is powder toner image.

103. The method according to claim 97 wherein said image is reversed printed onto said transfer sheet.

104. The method according to claim 97 wherein said transfer sheet is fabricated from polyvinylflouride material.

105. The method according to claim 97 wherein said image is unfused prior to transfer.

106. The method according to claim 97 wherein said powder image is cured after being electrostatically transferred.

107. The method according to claim 97 wherein said image is heat cured.

108. The method according to claim 97 wherein said image is cured by UV light application.

109. The method according to claim 97 wherein said image is cured by combination of heat and UV light.

110. A method for making a sign comprising the steps of:

generating an image for a sign; and

printing a powder image onto a sign substrate to form an electrostatically charged powder image thereon.

111. The method according to Claim 110 further comprising a step of:

curing said sign substrate at a predetermined temperature for a predetermined time.

112. The method according to claim 110 wherein said powder image is powder paint image.

113. The method according to claim 110 wherein said powder image is powder toner image.

114. An apparatus for generating a powder image comprising:

a photoconductor moving in a photoconductor direction;

a first corona assembly disposed in proximity to said photoconductor to provide said photoconductor with a photoconductor charge;

a light source assembly disposed downstream of said first corona assembly for selectively discharging said photoconductor to digitally generate a latent image on said photoconductor; and

a developer assembly disposed downstream of said light source assembly, said developer assembly generating charged powder image that retains electrostatic charge for subsequent transfer.

115. The apparatus according to claim 114 wherein said powder image is cured after being electrostatically transferred.

116. The apparatus according to claim 115 wherein said image is heat cured.

117. The apparatus according to claim 115 wherein said image is cured by UV light application.

118. The apparatus according to claim 115 wherein said image is cured by combination of heat and UV light.

119. The apparatus according to claim 114 wherein said powder image is powder paint image.

120. The apparatus according to claim 114 wherein said powder image is powder toner image.

121. The apparatus according to claim 114 further comprising:

a support disposed in proximity to a backside of a transfer sheet, wherein said support is held at a predetermined voltage for subsequent transfer of said powder image.

122. The apparatus according to claim 121 wherein said predetermined voltage is approximately ground.

123. The apparatus according to claim 114 wherein a sign substrate is held at a predetermined voltage to allow transfer of said powder image from said transfer sheet onto said sign substrate.

124. The apparatus according to claim 123 wherein said predetermined voltage is approximately negative two thousand volts.

125. The apparatus according to claim 114 wherein said powder image is initially transferred onto a transfer sheet and subsequently transferred from said transfer sheet onto a sign substrate.

126. The apparatus according to claim 125 wherein said transfer sheet is fabricated from a polyvinylflouride material.

127. The apparatus according to claim 114 wherein said powder image is transferred onto a sign substrate.

128. A substrate for accepting a generated image that is subsequently transferred onto a final substrate comprising:

a polyvinylfloride material sheet for accepting an image to be placed thereon and subsequently allowing transfer of said image onto a final substrate.

129. The substrate according to Claim 128 wherein said image is powder image.

130. An apparatus for generating an image comprising:

means for applying at least one colorant onto a substrate coated with an adhesive layer to generate an image atop of said adhesive layer; and

means for removing excess adhesive from said substrate to result in said image being disposed atop of said substrate with said adhesive layer being disposed therebetween.

131. The apparatus according to claim 130 further comprising:

means for curing said image.

132. The apparatus according to claim 130 further comprising:

means for fusing said image.

133. The apparatus according to claim 132 wherein said means for fusing is a non contact fuser.

134. The apparatus according to claim 130 wherein said means for applying at least one colorant is an inkjet system.

135. The apparatus according to claim 130 wherein said means for applying at least one colorant is an electrophotographic system.

136. The apparatus according to claim 130 wherein said means for applying at least one colorant is an electrostatic system.

137. The apparatus according to claim 130 wherein said means for applying at least one colorant is a thermal transfer system.

138. The apparatus according to claim 130 wherein said means for removing said excess adhesive is a system bringing a consumable sheet into contact with said substrate to remove said excess adhesive upon separation of said consumable sheet with said substrate leaving said image disposed atop of said substrate with said adhesive layer sandwiched therebetween.

139. The apparatus according to claim 138 wherein said means for removing said excess adhesive comprises:

a supply roll for dispensing said consumable sheet; and

a take up roll for taking up said consumable sheet with said excess adhesive disposed thereon.

140. The apparatus according to claim 139 further comprising:

a pressure roller disposed between said supply roll and said take up roll and substantially adjacent to said consumable sheet to apply pressure thereto to promote bonding between said consumable sheet and said excess adhesive.

141. The apparatus according to claim 138 wherein said consumable sheet material is foil.

142. The apparatus according to claim 138 wherein said consumable sheet functions as a protective sheet and is removed from said carrier sheet at a later time.

143. The apparatus according to claim 130 further comprising:

means for printing with predetermined background color over an entire image to remove excess adhesives to define an image background perimeter to allow subsequent printing over some portion of said image background perimeter with at least one color to generate a multi-color image.

144. The apparatus according to claim 130 further comprising:

means for printing with predetermined background color over an entire image to remove excess adhesives to define an image background perimeter to allow subsequent printing over some portion of said image background perimeter with at least one half-tone color to generate a half-tone image.

145. A method for generating a film image comprising the steps of:

providing a substrate with an adhesive layer;

printing an image onto said substrate with said adhesive layer such that said image is disposed atop of said adhesive layer; and

removing excess adhesive from said substrate such that said film image remains on said substrate with said adhesive layer sandwiched therebetween.

146. The method according to Claim 145 wherein said image is printed on a laser printer.

147. The method according to Claim 145 wherein powder paint is used to print said image.

148. The method according to Claim 145 wherein said image is printed on an ink jet printer.

149. The method according to Claim 148 wherein UV cure ink is used to print said image.

150. The method according to Claim 145 wherein said image is printed on a thermal transfer printer having an ink foil.

151. The method according to Claim 150 wherein said excess adhesive is removed with said ink foil.

152. The method according to Claim 151 wherein said excess adhesive adheres to said ink foil.

153. The method according to claim 145 wherein said step of printing further comprises the steps of:

printing with predetermined background color over an entire image to remove excess adhesives to define an image background perimeter; and

printing over some portion of said image background perimeter with at least one color to generate a multi-color image.

154. The method according to claim 145 wherein said step of printing further comprises the steps of:

printing with predetermined background color over an entire image to remove excess adhesives to define an image background perimeter; and

printing over some portion of said image background perimeter with at least one half-tone color to generate a half-tone image.

155. The apparatus according to Claim 46 wherein said adhesive is applied digitally over said image.

156. The apparatus according to Claim 46 wherein said adhesive is applied digitally over a substrate.

157. The apparatus according to Claim 48 wherein said colorant includes dye.

158. The apparatus according to Claim 48 wherein said colorant includes pigment.

159. The apparatus according to Claim 64 wherein said apparatus includes a plurality of photoconductors.

160. The apparatus according to Claim 159 wherein each of said plurality of photoconductors corresponds to a developer.

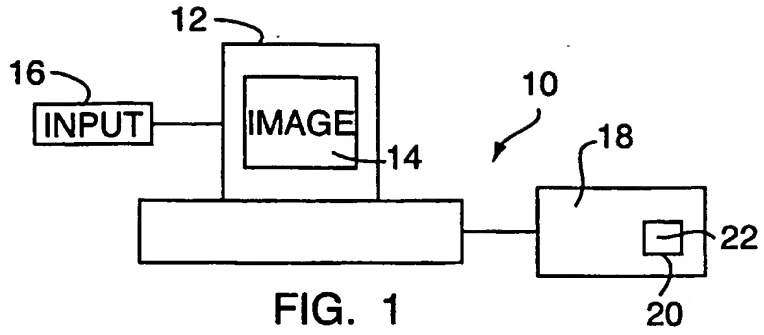


FIG. 1

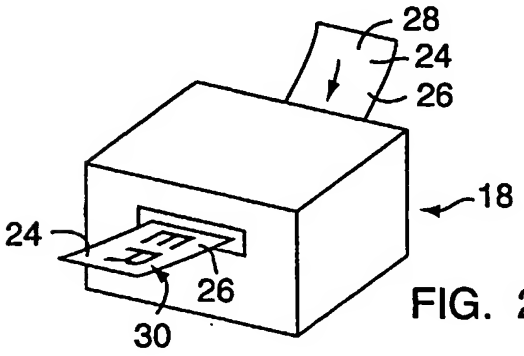


FIG. 2

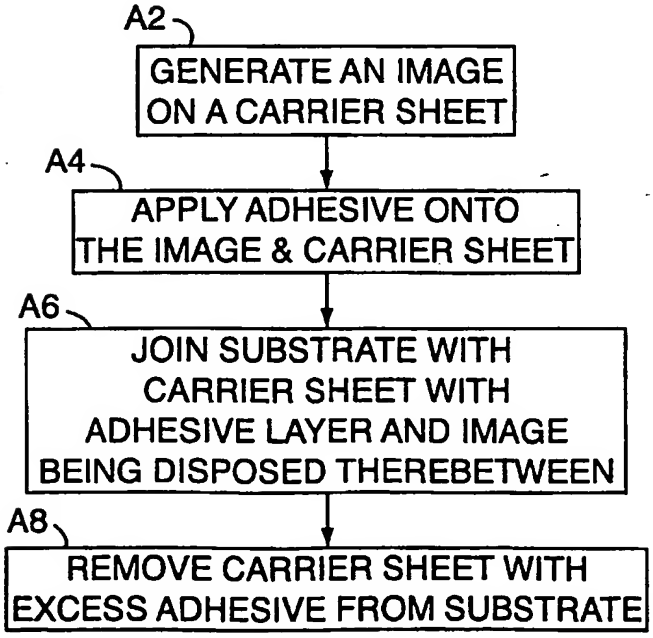
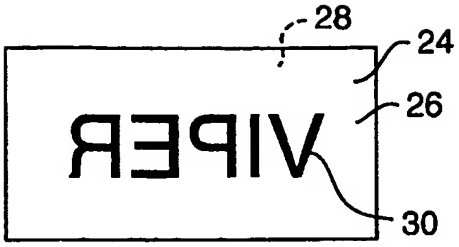


FIG. 3



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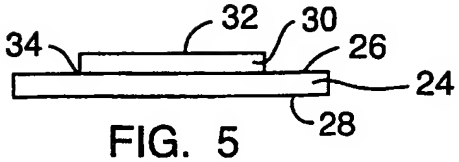

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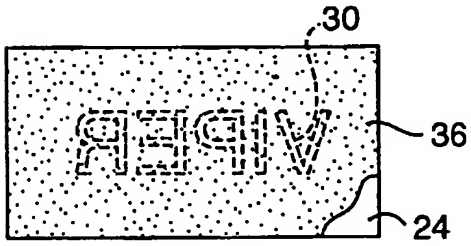

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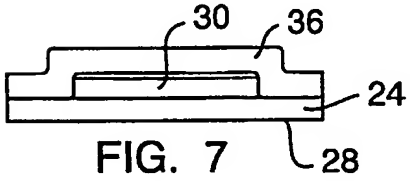

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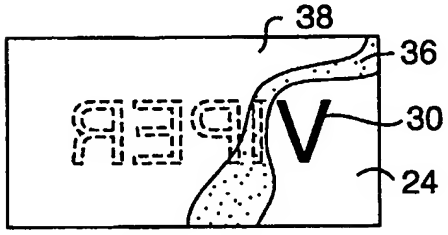


FIG. 8

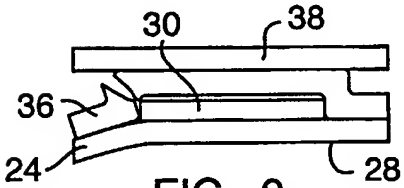


FIG. 9

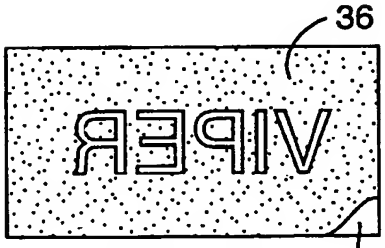
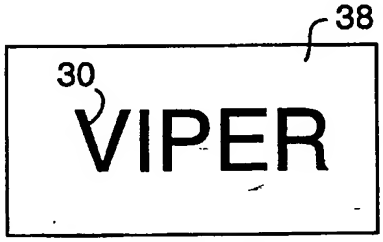


FIG. 10



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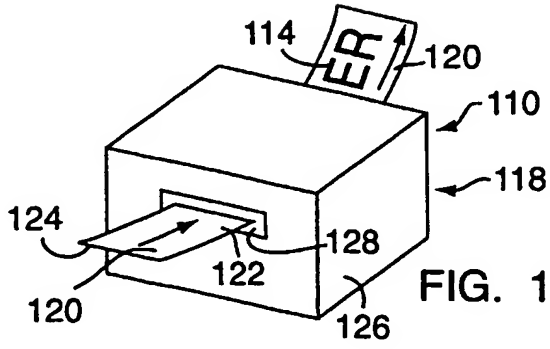

FIG. 12

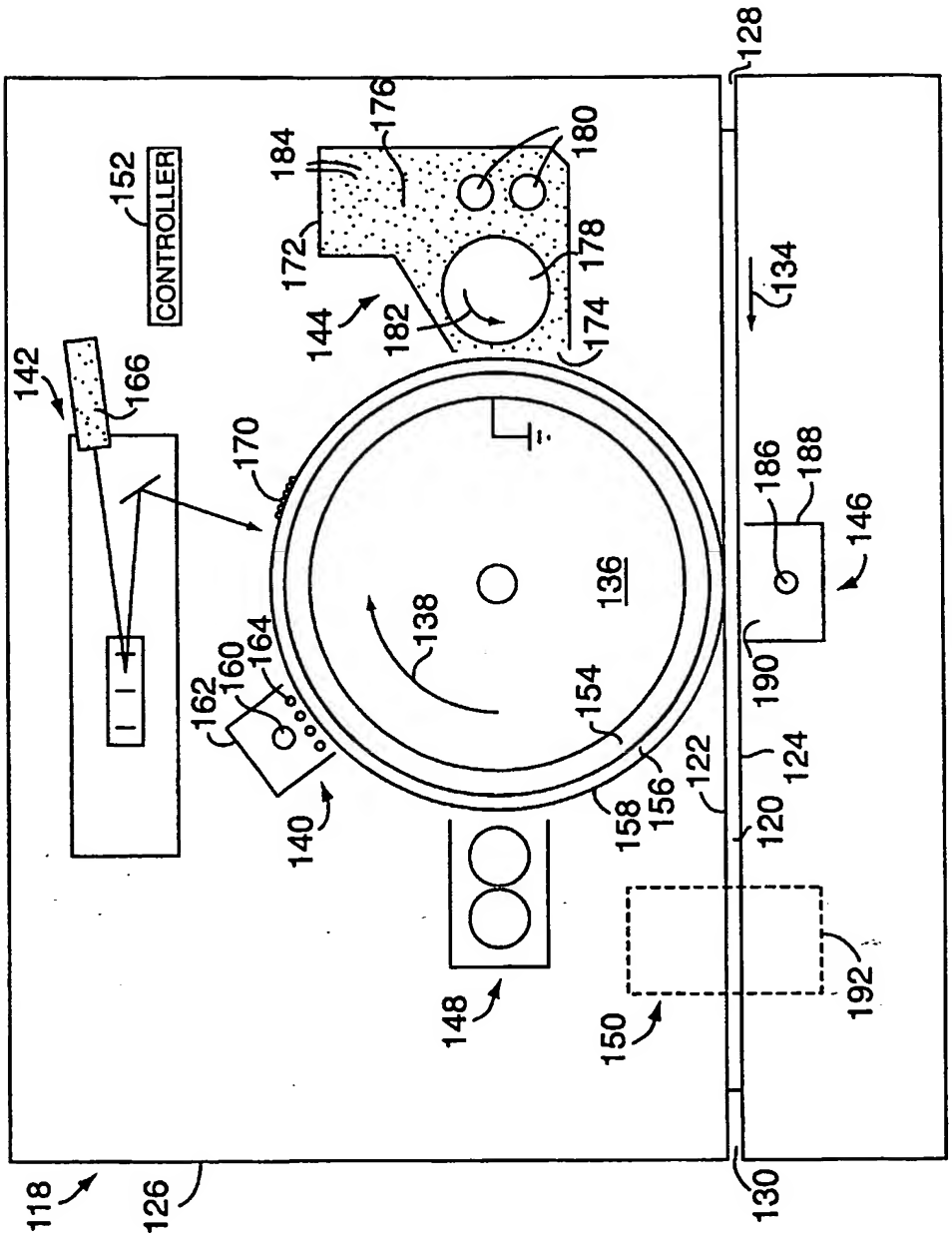
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FIG. 13

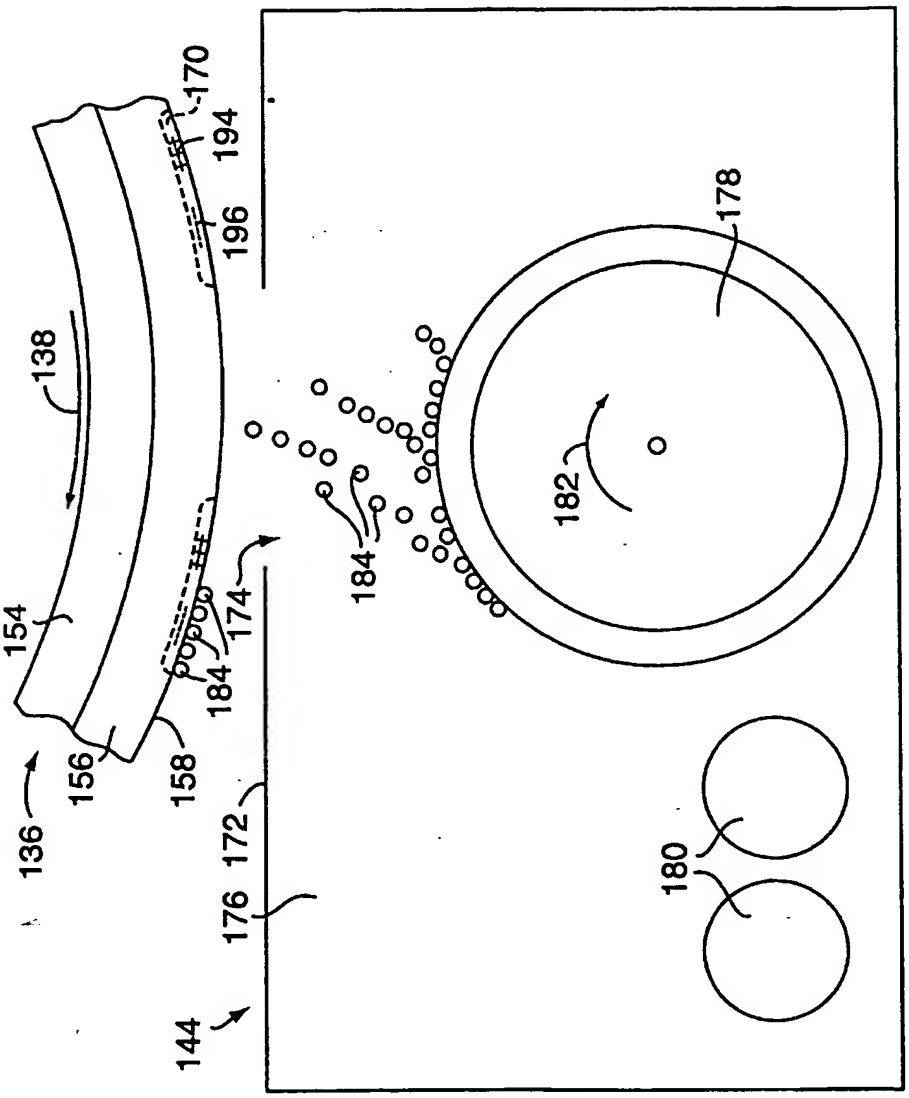
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FIG. 14

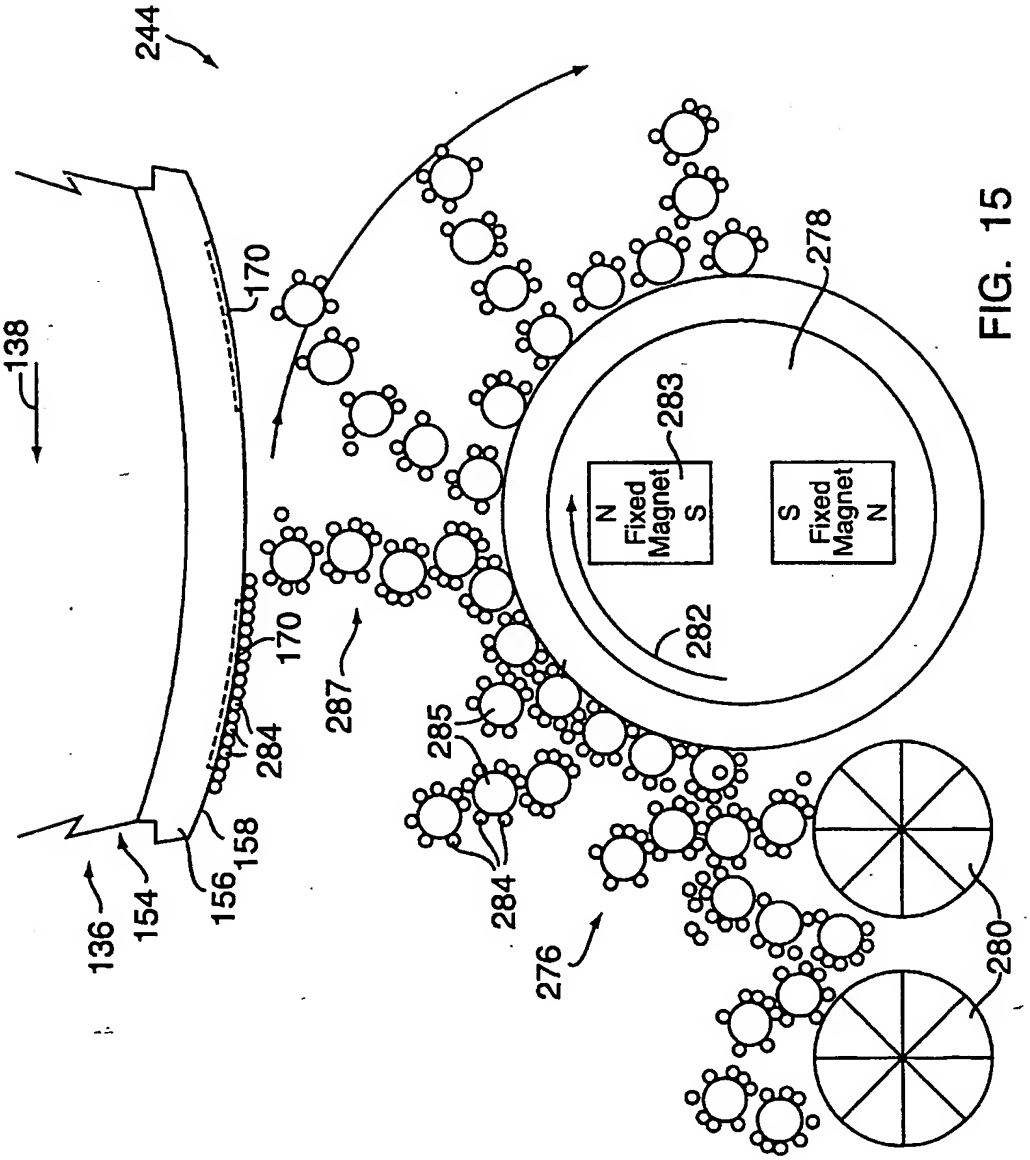
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FIG. 15

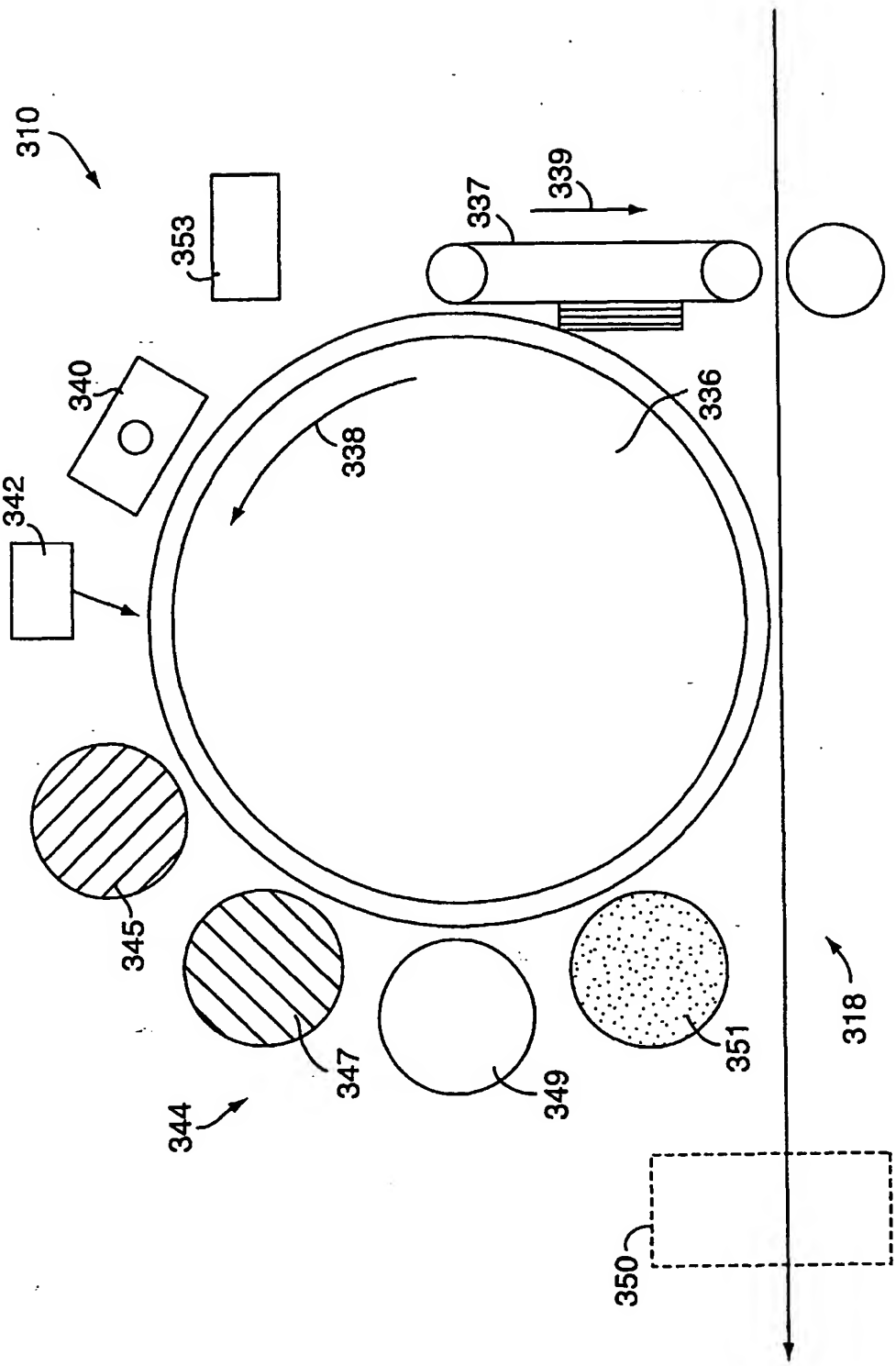

FIG. 16

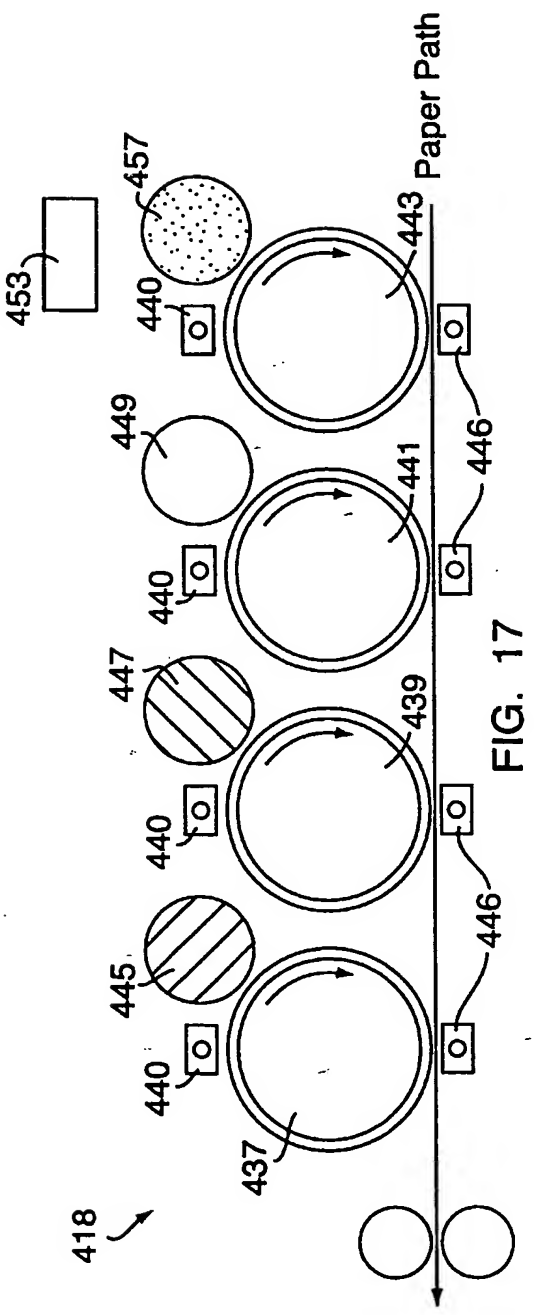
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FIG. 17

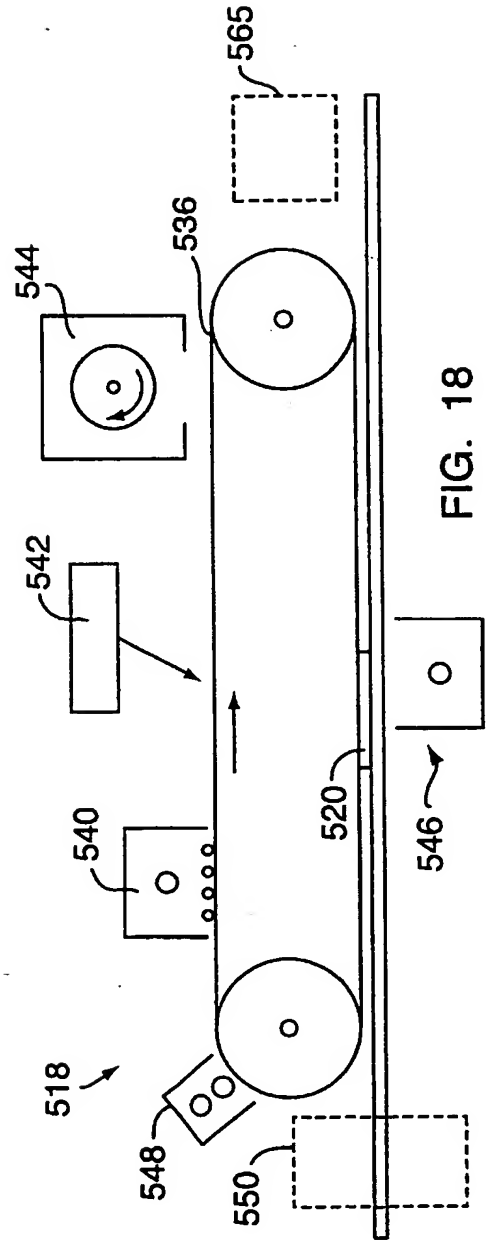
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FIG. 18

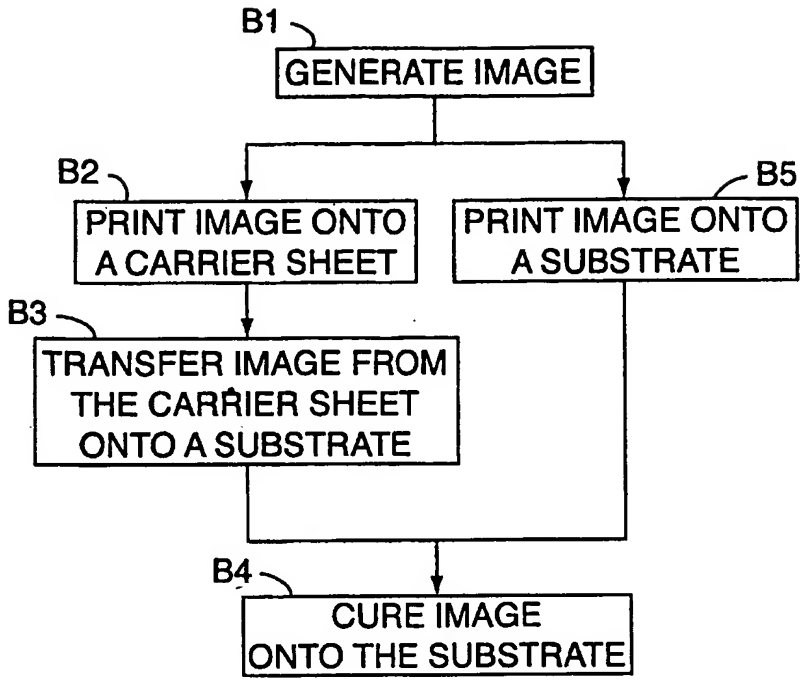


FIG. 19

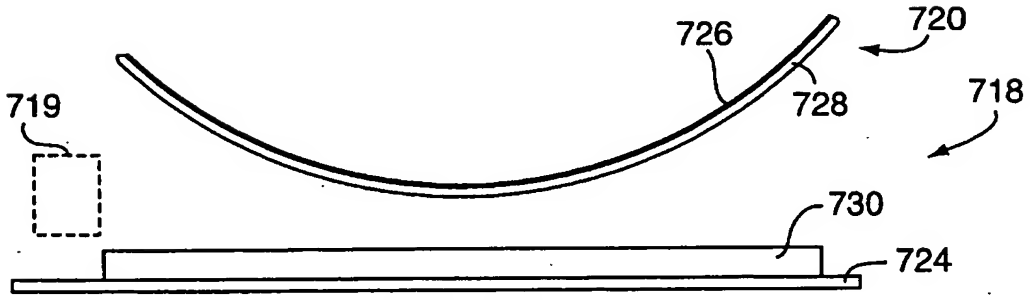


FIG. 21

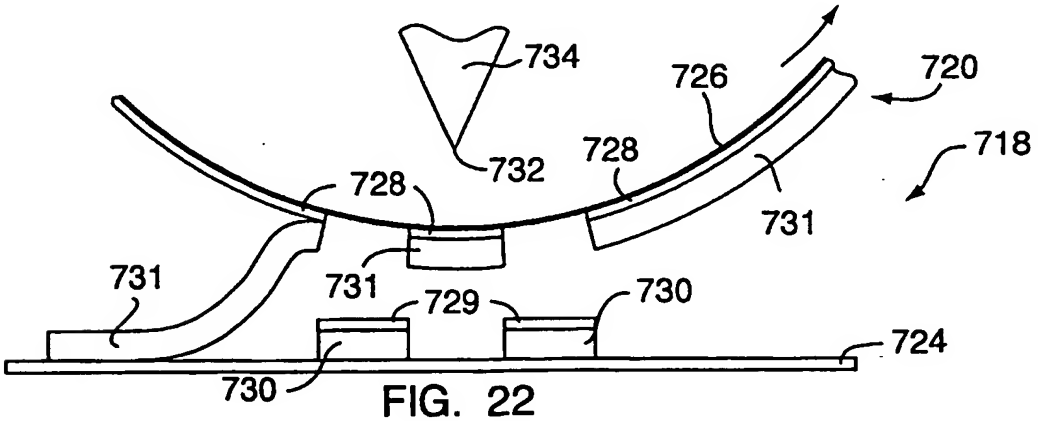
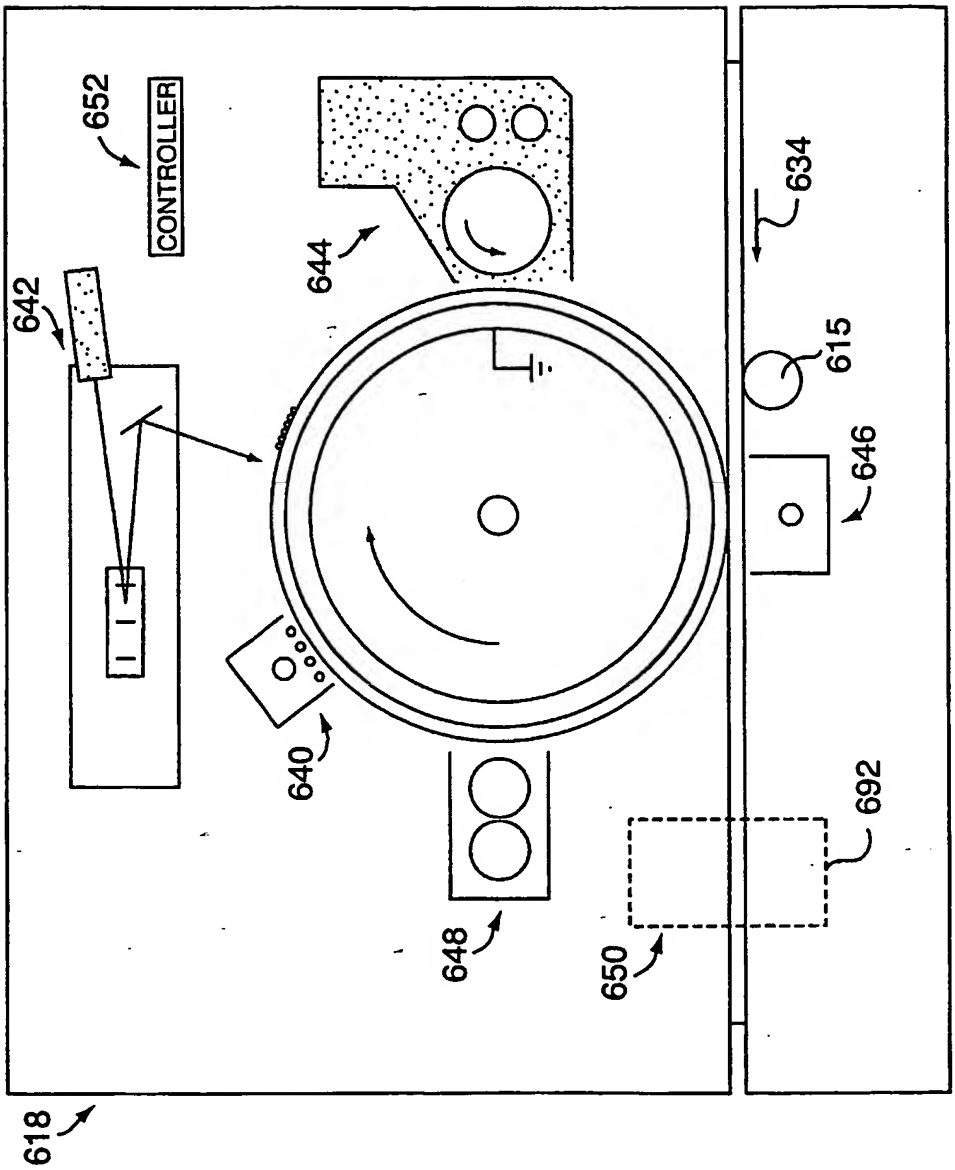


FIG. 22



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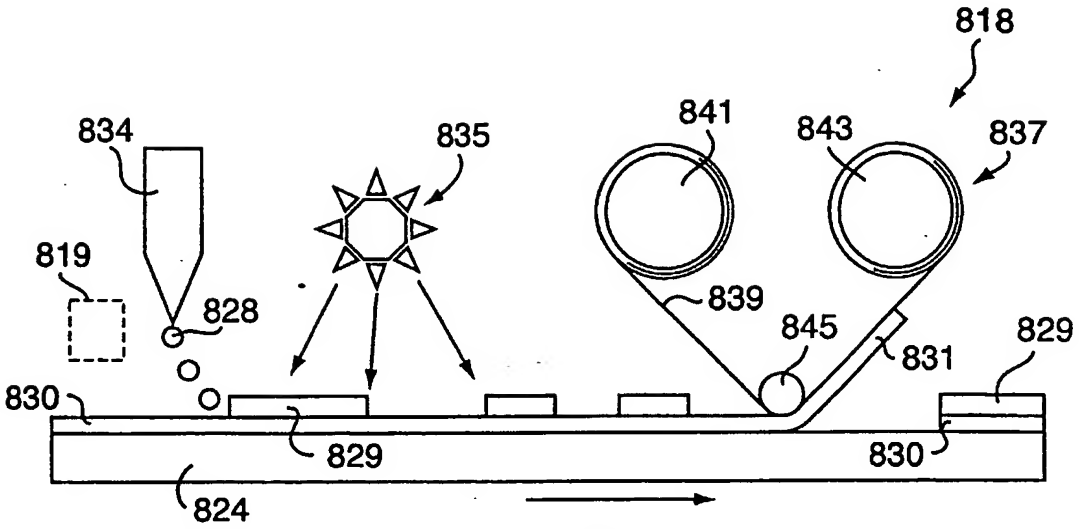
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FIG. 23

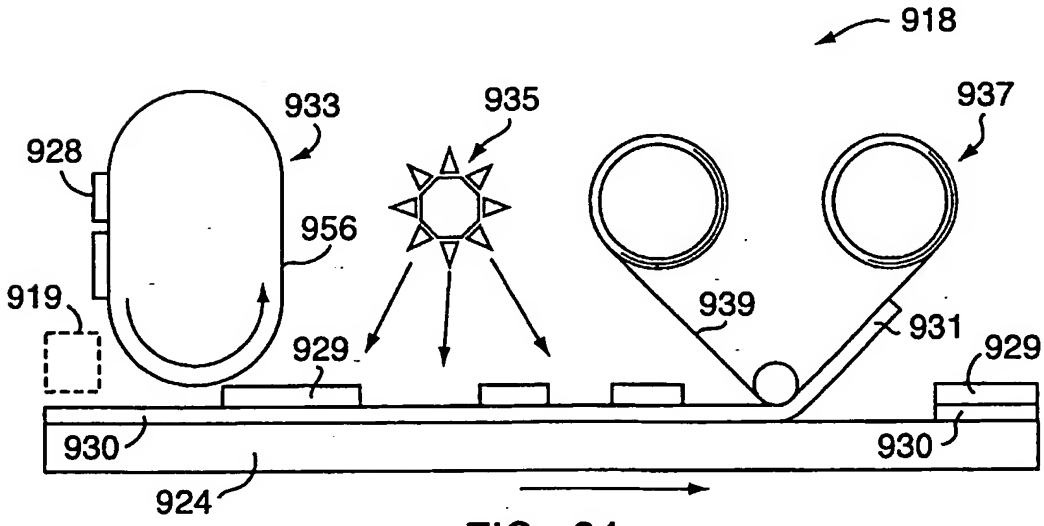
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FIG. 24

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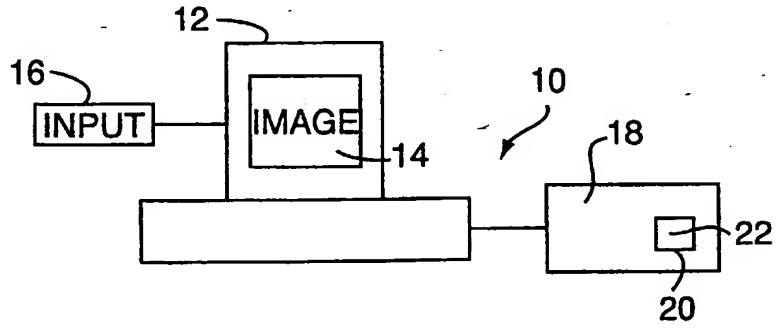
For two-letter codes and other abbreviations, refer to the "Guidance Notes on Codes and Abbreviations" appearing at the beginning of each regular issue of the PCT Gazette.

(54) Title: METHOD AND APPARATUS FOR MAKING SIGNS HAVING AN ADHESIVE



(57) Abstract: An apparatus for digitally generating an image comprises a photoconductor assembly (136) , a corona assembly (140), and a light source assembly (166) to generate a latent image on the photoconductor. The apparatus also includes a developer assembly (144) that includes a developer, such as powder paint, to generate an image. The apparatus may include a fuser (150) for generating a film image. The apparatus of the present invention may include a cartridge for storing and digitally applying adhesive (719, 819, 919) to the image. Furthermore, the apparatus of the present invention includes a controller (152) for selectively controlling voltages to control thickness of the image. Additionally, apparatus may include a consumable sheet (839, 939) to remove excess adhesive from the substrate.

WO 2003/066337 A3

INTERNATIONAL SEARCH REPORT

International Application No
I US 03/03768

A. CLASSIFICATION OF SUBJECT MATTER
IPC 7 B44C1/10 B44C1/17 B41M3/12 B41M5/025 B41J11/00
G03G7/00 G03G13/16 G03G8/00

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC 7 B44C B41M B41J G03G

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)
EPO-Internal, PAJ, WPI Data

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	WO 98/39166 A (FOCAL DESIGN STUDIOS LIMITED) 11 September 1998 (1998-09-11)	1-9, 13-19, 130,131, 134,135, 138-141
Y	see abstract page 1, line 1 - page 16, paragraph 3; figures 1-12	10-12, 20-24, 132,133, 136,137
Y	US 6 108 022 A (AVI LANDMAN ET AL.) 22 August 2000 (2000-08-22)	10
A	see abstract column 3, line 51 - column 7, line 11; figures 1-3,8-16	142-144

-/--

[X] Further documents are listed in the continuation of box C.

[X] Patent family members are listed in annex.

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"O" document referring to an oral disclosure, use, exhibition or other means

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"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.

"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
7 April 2004	08. 11. 2004

Name and mailing address of the ISA	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Tx. 31 651 epo nl, Fax: (+31-70) 340-3016	Greiner, E

Form PCT/ISA/210 (second sheet) (January 2004)

INTERNATIONAL SEARCH REPORT

International Application No
P /US 03/03768

C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	US 4 900 597 A (STEPHEN KURTIN) 13 February 1990 (1990-02-13) the whole document	11,12, 20-24, 132,133, 136,137
A	US 5 871 837 A (PAUL C. ADAIR) 16 February 1999 (1999-02-16) cited in the application the whole document	1-24, 130-144
A	US 6 322 265 B1 (DAVID M. MINDEK ET AL.) 27 November 2001 (2001-11-27) cited in the application the whole document	1-24, 130-144
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INTERNATIONAL SEARCH REPORT

International application No.
PCT/US 03/03768

Box I Observations where certain claims were found unsearchable (Continuation of item 1 of first sheet)

This International Search Report has not been established in respect of certain claims under Article 17(2)(a) for the following reasons:

1. ☐ Claims Nos.:
because they relate to subject matter not required to be searched by this Authority, namely:

2. ☐ Claims Nos.:
because they relate to parts of the International Application that do not comply with the prescribed requirements to such an extent that no meaningful International Search can be carried out, specifically:

3. ☐ Claims Nos.:
because they are dependent claims and are not drafted in accordance with the second and third sentences of Rule 6.4(a).

Box II Observations where unity of invention is lacking (Continuation of item 2 of first sheet)

This International Searching Authority found multiple inventions in this international application, as follows:

see additional sheet

1. ☐ As all required additional search fees were timely paid by the applicant, this International Search Report covers all searchable claims.

2. ☐ As all searchable claims could be searched without effort justifying an additional fee, this Authority did not invite payment of any additional fee.

3. ☐ As only some of the required additional search fees were timely paid by the applicant, this International Search Report covers only those claims for which fees were paid, specifically claims Nos.:

4. ☒ No required additional search fees were timely paid by the applicant. Consequently, this International Search Report is restricted to the invention first mentioned in the claims; it is covered by claims Nos.:

see annex

Remark on Protest

☐ The additional search fees were accompanied by the applicant's protest.

☐ No protest accompanied the payment of additional search fees.

FURTHER INFORMATION CONTINUED FROM PCT/ISA/ 210

This International Searching Authority found multiple (groups of) inventions in this international application, as follows:

1. claims: 1 - 24, 130 - 144

   Adhering an image to a substrate

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2. claims: 25 - 39, 97 - 113

   Powder paint

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3. claims: 40 - 96, 114 - 127, 155 - 160

   Apparatus for digitally generating an image comprising a movable photoconductor

   ---

4. claims: 128, 129

   Image accepting substrate comprising a polyvinylfloride material

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5. claims: 145 - 154

   Printing atop an adhesive layer on a substrate

INTERNATIONAL SEARCH REPORT

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